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Final Environmental Impact Statement

on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site

Volume 1

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ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

the Board	Defense Nuclear Facilities Safety Board
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
IDC	Item Description Code
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
Rocky Flats	Rocky Flats Environmental Technology Site
WIPP	Waste Isolation Pilot Plant

Chemicals and Units of Measure

ac	acre
Al/NO_3	aluminum nitrate
BTU	British thermal unit
CDPHE	Colorado Department of Public Health and the Environment
Ci	curie
cm	centimeter
CO	carbon monoxide
ft	foot
g	gram
gal	gallon
ha	hectare
HAN	hydroxylamine nitrate
hr	hour
in	inch
kg	kilogram
km	kilometer
km/sec	kilometers per second
KOH	potassium hydroxide
kW	kilowatt
L	liter
lb	pound
m	meter
m/s	meters per second
M	molar
mg	milligram
mi	mile
mi/sec	miles per second
min	minute
mm	millimeter
mph	miles per hour
mrem	millirem
MWe	megawatts electric
MWh	megawatt hours
n	neutron
nCi	nanocuries
oz	ounce
Pb	lead
PM	particulate matter
ppm	parts per million
rad	radiation absorbed dose
sec	second
yd	yard
yr	year
°C	degrees Celsius
°F	degrees Fahrenheit

1. INTRODUCTION

During the Cold War, the United States Department of Energy (DOE) and its predecessor agencies conducted various activities associated with the production of materials for use in nuclear weapons. Several intermediate products and wastes were generated as a result of those operations, some of which are still in storage at various DOE sites. Now that the Cold War is over and the United States has ceased production of fissionable nuclear weapons materials, DOE is conducting activities to safely manage, clean up, and dispose of (where appropriate) those intermediate products and wastes. Among the intermediate products and wastes requiring proper management and preparation for disposal or other disposition are plutonium residues and scrub alloy currently stored at the Rocky Flats Environmental Technology Site (Rocky Flats)[1] near Golden, Colorado.

This Final Environmental Impact Statement (EIS) identifies potential alternatives and impacts associated with the proposed action to process certain plutonium residues and all of the scrub alloy currently stored at Rocky Flats. While ongoing stabilization activities at Rocky Flats are addressing immediate health and safety concerns associated with existing storage conditions, the indefinite storage of these materials, even after stabilization, would continue to present health and safety concerns that could only be eliminated by disposal or other disposition of the materials. Thus, this EIS evaluates alternative processing technologies to prepare these materials for disposal as transuranic waste at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, or other disposition.

1.1 BACKGROUND

Plutonium residues and scrub alloy were generated during recovery and purification of plutonium and manufacture of components for nuclear weapons.

- Approximately 125,000 kilograms (kg) (275,600 pounds [lb]) of residues (containing about 5,800 kg [12,800 lb] of plutonium) and approximately 700 kg (1,540 lb) of scrub alloy (containing about 200 kg [440 lb] of plutonium) are currently stored at various DOE sites.

- Of this amount in the DOE complex, approximately 106,600 kg (235,000 lb) of the residues (containing about 3,000 kg [6,600 lb] of plutonium) and almost all of the scrub alloy are stored in various types of containers in 6 former plutonium production facilities at Rocky Flats. In order to address health and safety concerns associated with the continued storage of these materials at Rocky Flats, stabilization activities are already underway for these materials. The stabilization activities are being conducted in accordance with the *Environmental Assessment, Finding of No Significant Impact, and Response to Comments—Solid Residue Treatment, Repackaging, and Storage* (the "Solid Residue Environmental Assessment") (DOE 1996h).

- The remaining approximately 18,400 kg (40,600 lb) of plutonium residues are stored at the Savannah River Site, Hanford Site, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory. Approximately 6 kg (13 lb) of scrub alloy are stored at the Savannah River Site. The residues stored at these sites are not the subject of this EIS. They are addressed in separate National Environmental Policy Act (NEPA) reviews identified in Section 1.5.

[1] *Rocky Flats was previously known as the "Rocky Flats Plant" while it was being used to produce components for nuclear weapons.*

This EIS addresses a subset of plutonium residues (42,200 kg, or 93,000 lb) and all of the scrub alloy currently stored at Rocky Flats. Even after the stabilization activities underway at Rocky Flats are completed, this subset of the Rocky Flats plutonium residues and all of its scrub alloy would still continue to present health and safety concerns because they would not be in forms that would allow for their disposal or other disposition. This EIS addresses the processing of this subset of Rocky Flats' plutonium residues and all of the Rocky Flats scrub alloy in order to not only stabilize them but to also prepare them for disposal or other disposition, with the primary goal of eliminating the health and safety issues associated with continued storage of these materials.

The Rocky Flats plutonium residues consist of four broad categories that were described in the Solid Residue Environmental Assessment: ash, salts, wet residues, and direct repackage residues. The residues were grouped into these categories due to chemical similarities or similarities in the manner in which they could be managed. The approximate quantities in each residue category and the scrub alloy inventory requiring further processing to meet the requirements for disposal or other disposition are summarized in **Table 1–1**. A more detailed breakout of these materials is contained in **Table 2-1**.

Table 1–1 Plutonium Residues (by Category) and Scrub Alloy Inventory Covered under this EIS

Category	*Inventory, kg (lb)*	*Plutonium Content, kg (lb)*
Ash Residues include incinerator ash and firebrick fines; sand, slag, and crucible; graphite fines; and inorganic ash residues.	20,060 (44,200)	1,160 (2,560)
Salt Residues include molten salt extraction salt residues, electrorefining salt residues, and direct oxide reduction salt residues.	14,900 (32,800)	1,000 (2,200)
Wet Residues include wet combustible residues, plutonium fluoride residues, filter media, Raschig rings, sludges, and greases/oily sludges.	4,300 (9,500)	290 (640)
Direct Repackage Residues include dry combustible residues, glass residues, miscellaneous residues, and graphite and firebrick.	2,900 (6,400)	130 (290)
Scrub Alloy	700 (1,540)	200 (440)

1.2 PURPOSE AND NEED FOR AGENCY ACTION

The purpose and need for agency action is to process certain plutonium residues and scrub alloy currently in storage at Rocky Flats (summarized in Table 1-1 above) to address health and safety concerns regarding storage of the materials, as raised by the Defense Nuclear Facilities Safety Board (the Board) in Recommendation 94-1, *Improved Schedule for Remediation in the Defense Nuclear Facilities Complex* (DNFSB 1994), and to prepare the materials for offsite disposal or other disposition. These actions would be taken in a manner that supports site closure and limits worker exposure and waste production. Disposal or other disposition would eliminate health and safety concerns associated with indefinite storage of these materials.

The Solid Residue Environmental Assessment (DOE 1996h) addressed the potential environmental impacts associated with stabilizing the entire 106,600-kg (235,000-lb) inventory of Rocky Flats' plutonium residues to provide for safe storage until final disposition of the residues could be decided and implemented. Because of the need for expeditious action to resolve concerns with storage of the plutonium residues at Rocky Flats, the Solid Residue Environmental Assessment addressed neither disposal or other disposition of the residues after these materials were stabilized nor stabilization of the scrub alloy. Furthermore, although stabilization activities to mitigate the risks associated with the current storage condition of the plutonium residues are in

progress at Rocky Flats, based on the Finding of No Significant Impact issued after completion of the Solid Residue Environmental Assessment, less than 10 percent of the Rocky Flats plutonium residues addressed in this EIS and none of the scrub alloy have been stabilized to date. Accordingly, DOE considers it prudent to consider in this EIS processing and other alternatives that not only would stabilize the remaining plutonium residues to address the health and safety concerns raised by the Board's Recommendation 94-1, if necessary, but that also would convert them into forms that would allow their disposal or other disposition. To that end, the materials must have safeguards terminated.

1.2.1 Safeguards Termination Requirements

In the process of considering disposal options for the Rocky Flats plutonium residues and scrub alloy, DOE determined that the majority of the residues would be suitable for disposal at WIPP after stabilization. Approximately 42,200 kg (93,000 lb) out of the total 106,600 kg (235,000 lb) of plutonium residues currently stored at Rocky Flats, however, could not be sent to WIPP for disposal in their present forms because they contain plutonium concentrations exceeding DOE safeguards termination limits. Although these plutonium residues would not be directly usable in nuclear weapons, they currently contain plutonium concentrations too high to be transported to and staged for disposal at WIPP unless safeguards controls were maintained.[2] DOE does not plan to maintain such controls for materials transported to and staged at WIPP prior to disposal because WIPP is not designed to allow implementation of such controls. Thus, these materials in their present forms are effectively foreclosed from being disposed of at WIPP unless a variance to safeguards termination limits is applied (see discussion below).

For the Rocky Flats plutonium-bearing materials to be disposed of as transuranic waste at WIPP, they must meet the following requirements:

- ***Performance-based requirements contained in the WIPP waste acceptance criteria and***
- ***Safeguards termination requirements, either by having:***

  -plutonium concentrations that are below the safeguards termination limits for those material forms, or

  -a variance to the safeguards termination limits.

The term "safeguards" refers to those measures (e.g., recordkeeping, monitoring, and physical protection) that DOE and other organizations holding nuclear materials must take to ensure that the materials are not stolen or diverted for illicit purposes. The safeguards requirements that are applicable to nuclear materials held by DOE are specified in DOE Order 5633.3B, "Control and Accountability of Nuclear Materials" (DOE 1994c). The term "safeguards termination requirements" refers to those steps that must be taken, or conditions that must exist, before nuclear materials are rendered sufficiently unattractive as a source of fissile material for illicit purposes to allow them to be exempted from safeguards controls. These requirements include "safeguards termination limits" that define, for certain categories and forms of material, the maximum weight percentage of special nuclear material that can be present in materials without subjecting them to safeguards controls.

For certain materials that contain a concentration of plutonium or other special nuclear material above safeguards termination limits, special conditions, such as the combination of the processing method, the controls in place for normal handling of transuranic waste, and the limited quantity of special nuclear material present at any particular place and time, may preclude the need for the strict material control and accountability imposed by safeguards. If a DOE site identifies such a special condition, the site may request approval of a

[2]*Hereinafter, in this EIS the terms "disposal" or "disposed of" at WIPP include the steps of transporting to and staging prior to disposal.*

"variance" to safeguards termination limits from DOE's Office of Nonproliferation and National Security, Office of Safeguards and Security.

When a variance to safeguards termination limits is granted, it is recognized that the materials would no longer need to be subject to strict material control and accountability as special nuclear material. The materials would still be controlled and guarded in accordance with other DOE management practices and physical security procedures, as specified in the documentation explaining the basis for the variance.

If a variance to safeguards termination limits is granted, the materials must still meet WIPP's waste acceptance criteria. WIPP's waste acceptance criteria are performance-based and are independent of safeguards termination requirements.

WIPP is designed to incorporate security provisions appropriate to its function (which includes disposal of materials containing small amounts of plutonium), but not to meet the more stringent nuclear material safeguards requirements. As a result, materials must meet safeguards termination requirements before any plutonium residue could be disposed of in WIPP. There are three approaches that could be taken to satisfy the safeguards termination requirements, as described below:

- ***The concentration of plutonium, or other fissile elements, in the material must be very low (e.g., 0.1 weight percent). Many of the Rocky Flats residues (i.e., approximately 64,400 kg [142,000 lb]) could be shipped to WIPP after completion of the stabilization processes analyzed in the Solid Residue Environmental Assessment because they contain so little plutonium that they already meet the safeguards termination limits. Other residue materials could be processed by either diluting the residues with materials that are similar, or by removing some or all of the plutonium.***
- ***Materials with somewhat higher but still small (i.e., up to 5 weight percent) concentrations of plutonium or other fissile elements (e.g., U-233 and U-235) could be immobilized by converting them into a glass or ceramic form, from which it would be very difficult to extract the plutonium or other fissile elements.***
- ***A variance to safeguards termination limits could be implemented for some materials under special conditions (see text in Section 1.2.1) to allow for disposal at WIPP.***

1.2.2 Disposition of Waste and Separated Plutonium

For approximately 64,400 kg (142,000 lb) of the plutonium-bearing residues currently being stabilized in accordance with the Finding of No Significant Impact issued after completion of the Solid Residue Environmental Assessment, there are no issues of safeguards controls and these materials may be disposed of at WIPP. These residues are not addressed in this EIS.

The processing options for the materials being considered in this EIS could yield transuranic waste and/or plutonium metal or oxide, as well as low-level radioactive waste and other material managed as high-level waste, which are subject to different disposal/disposition options. Disposal of transuranic waste is planned at WIPP. Therefore, the transuranic waste would be required to meet WIPP waste acceptance criteria. For plutonium metal or oxide that would result from processing technologies involving plutonium separation, disposition options under consideration include immobilization of surplus plutonium in glass or ceramic material for disposal in a monitored geologic repository pursuant to the Nuclear Waste Policy Act. Low-level waste that would result from some of the processing options would be disposed of in accordance with the site's low-level waste disposal practices. Impacts from these disposal and other disposition options are addressed in other NEPA documents, as identified in Section 1.5. Additional NEPA review would be required if the scrub alloy is converted directly into transuranic waste (without plutonium separation) and disposed of in WIPP because this material was not included in the WIPP baseline estimates.

1.3 SCOPE OF THIS EIS

This EIS evaluates technical alternatives for management of approximately 42,200 kg (93,000 lb) of plutonium residues, containing approximately 2,600 kg (5,700 lb) of plutonium, and approximately 700 kg (1,540 lb) of scrub alloy, currently in storage at Rocky Flats, containing about 200 kg (440 lb) of plutonium to facilitate their disposal or other disposition. The four technical alternatives are:

(1) No Action (Stabilize and Store) -- Under the No Action Alternative, the Rocky Flats plutonium residues and scrub alloy would be stabilized, if necessary, and stored there for an indefinite period pending disposal or other disposition. The materials processed under this alternative would not meet safeguards termination limits (see Section 1.2.1), and the health and safety risks associated with continued storage at Rocky Flats would not be eliminated.

(2) Processing without Plutonium Separation -- Under this approach, materials covered by this EIS would be processed into forms that meet safeguards termination limits using processes such as immobilization[3] or blend down (without separating the plutonium), and would thus be ready for shipment to WIPP for disposal.

(3) Processing with Plutonium Separation -- Under this approach, materials covered by this EIS would be processed using approaches that separate the plutonium from the material. DOE would manage the separated weapons-usable surplus plutonium in accordance with decisions made under the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* (DOE 1996a) and the *Surplus Plutonium Disposition Draft Environmental Impact Statement* (DOE 1998a). Transuranic wastes resulting from this alternative would be disposed of in WIPP and low-level wastes would be disposed of in accordance with the processing site's low-level waste disposal practices.

(4) Combination of Processing Technologies -- Under this approach, a combination alternative comprised of certain elements of the technologies analyzed under Alternatives 1 and 2 would be used.

The objective of the proposed agency action is to process the material, if necessary, into a form and concentration that is suitable for disposal or other disposition for the purpose of eliminating the health and safety impacts associated with continued storage of these materials. DOE would prefer to integrate management decisions regarding the materials within the scope of this EIS with stabilization decisions resulting from the Solid Residue Environmental Assessment. The intent of such integration would be to reduce the need to handle these materials, thereby reducing worker risk and costs associated with achieving a material form suitable for disposal or other disposition.

1.3.1 Changes between the Draft and Final Versions of this EIS

Changes between the draft and final versions of this EIS have been made as a result of comments received on the Draft EIS and further information DOE has gained as a result of continued characterization of the Rocky Flats residues. All revisions and changes made since the issuance of the Draft EIS are indicated by sidebars in this document. Key changes are highlighted in this section.

Variances

[3] *The immobilization technologies referred to here consist of processes such as cementation, vitrification, and cold ceramification, and are not a part of the immobilization of weapons-usable plutonium as discussed in Section 1.2.2, "Disposition of Waste and Separated Plutonium."*

The Draft EIS, issued in November 1997, identified certain residue categories for which variances to the safeguards termination limits had been approved by the DOE Office of Nonproliferation and National Security, Office of Safeguards and Security. These included combustible residues, glass and graphite residues, most inorganic residues, and some salt (direct oxide reduction) and filter residues. The Draft EIS also identified additional residue categories for which Rocky Flats was considering variance requests. These included ash and sludge residues, molten salt extraction and electrorefining salt residues, and high-efficiency particulate air filter residues.

As a result of further characterization of the residues since the Draft EIS was issued, Rocky Flats concluded that many residues would only need to be repackaged prior to disposal at WIPP because much of the residue inventory would not require further stabilization prior to repackaging to meet WIPP waste acceptance criteria. For the remaining residues, where further stabilization would be required, it could be accomplished by the alternative technologies analyzed in this EIS. Rocky Flats further concluded that, given the nature of the materials, their plutonium concentration, and the waste management controls that would be in effect during the transportation to and storage at WIPP, safeguards controls would not be needed to ensure the absence of proliferation risks. Therefore, Rocky Flats requested and obtained a variance to safeguards termination limits that covers all residues with plutonium concentrations below 10 percent. This includes all the material categories that were specified in the Draft EIS as being covered by a variance or for which DOE indicated that variances were being pursued. DOE chose 10 percent plutonium by weight as the upper limit for Rocky Flats residues being repackaged for direct disposal to WIPP because at that plutonium concentration the material would not be deemed suitable or attractive for use in an improvised nuclear device and would require extensive processing to be converted into a form usable in such a device (DOE 1998c). To achieve this concentration level, limited quantities of relatively high plutonium concentration materials (i.e., in the range of about 20 percent to 50 percent plutonium) could be blended with low plutonium concentration materials having the same characteristics or with inert materials. Therefore, the Final EIS evaluates a new Alternative 4 (see below) to address materials that have an approved variance.

Alternative 4 - Combination of Processing Technologies

DOE has combined elements of the processing technologies analyzed in Alternative 1 (stabilization and repackaging) and Alternative 2 (blending) into an additional Alternative 4 (Combination of Processing Technologies) in order to specifically address materials which have received a variance to safeguards termination limits. Specifically, Alternative 4 includes the following:

- stabilization, if necessary;
- blending with similar or inert materials, if necessary, to achieve a 10 percent plutonium concentration limit (up to 6,800 kg (15,000 lb) of the residues, approximately 16 percent, contain more than 10 percent plutonium);
- repackaging for disposal at WIPP; and
- implementation of a variance to safeguards termination limits.

Preferred Alternative

The Draft EIS identified preferred processing technologies for all residues except filter media residues and sludge residues. Since issuance of the Draft EIS more has been learned about the materials, and because a variance to safeguards termination limits has been approved for many of the residues subsequent to issuance of the Draft EIS, the preferred processing technologies have changed for many material categories. The Final EIS now identifies preferred processing technologies for all residue categories and scrub alloy, collectively referred to as the "Preferred Alternative" (see Section 2.5.2).

New Processing Technologies

The Final EIS also introduces two new candidate processing technologies: cold ceramification of incinerator ash residues at Rocky Flats (see Section 2.4.1) and preprocessing direct oxide reduction salt residues at Rocky Flats with acid dissolution/plutonium oxide recovery at Los Alamos National Laboratory (see Section 2.4.2).

Cold ceramification was suggested for inclusion in the EIS during public comments and has recently been successfully demonstrated for Rocky Flats incinerator ash residues. This technology forms a very stable waste form. The processing steps for cold ceramification are similar to those used in cementation, which was analyzed for implementation at Rocky Flats in the Draft EIS. The major difference in these two processes is that they use different binding materials. Because these two processes have similar processing steps, environmental impacts both to workers and to the offsite public population would be similar.

At the recommendation of Los Alamos National Laboratory, the acid dissolution/plutonium oxide recovery process at Los Alamos National Laboratory was added to the Final EIS for direct oxide reduction salt residues. This process is similar to the acid dissolution/plutonium oxide recovery process analyzed in the Draft EIS for implementation at Rocky Flats and would impose similar environmental impacts both to workers and to the offsite public population. This process was previously used at Los Alamos National Laboratory to recovery plutonium from direct oxide reduction salt residues and therefore is considered to have a low technical uncertainty. In the Draft EIS, the water leach process, which has a higher technical uncertainty, was analyzed for separating plutonium oxide from direct oxide reduction salt residues at Los Alamos National Laboratory.

Contingency Storage Analysis

As a result of public comments, the risks associated with the storage of the plutonium residues and scrub alloy following processing and/or repackaging have been evaluated, and are discussed in Section 4.14 of the Final EIS. The evaluations consider a 20-year storage period for Alternative 1 (No Action - Stabilize and Store) and storage of the product for the other alternatives while waiting for transport of the transuranic waste to WIPP or for final disposition of separated plutonium.

Modified Impact Assessments

Refinements have been made to the impact analyses in the Final EIS. Some of the changes occurred because DOE re-evaluated many of the processing technologies and introduced some new processing technologies. DOE assumed a higher frequency of severe damage due to earthquakes at Buildings 707 and 707A at Rocky Flats because structural calculations were not completed until after the Draft EIS was published. Furthermore, the calculations of the potential for worker health impacts due to exposure to hazardous chemicals were refined to account for more realistic assumptions.

1.4 DECISIONS TO BE MADE BASED ON THIS EIS

1.4.1 Decisions

To ensure that the plutonium residues and scrub alloy addressed in this EIS are properly prepared for disposal or other disposition (which would eliminate the health and safety risks associated with further management of these materials) and are stored safely before their disposal or other disposition, the following decisions must be made:

- Whether any repackaging or processing[4] of the plutonium residues and scrub alloy should occur, and if so:

  – How much of the plutonium residues and scrub alloy should be processed?

  – What processing approach should be used for each plutonium residue category and for the scrub alloy?

- Where processing and any subsequent management of the plutonium residues and scrub alloy should occur. Different sites could possibly be chosen for management of different residues and the scrub alloy or for different portions of a single residue category (for example, if differences in the weight percent plutonium contained in a portion of a residue category, or other detailed differences in the residue chemistry, make such distinctions desirable). [This includes consideration of whether various portions of the plutonium residues and scrub alloy should be processed through DOE's existing chemical separation facilities at the Savannah River Site or at Los Alamos National Laboratory in addition to Rocky Flats.]

These decisions will be announced in Records of Decision in accordance with the phased schedule identified in Section 1.4.2.

1.4.2 Process and Schedule for Decisions

With the exception of the two new candidate processing technologies identified in Section 1.3.1, above, all of the alternatives analyzed in the EIS for management of Rocky Flats plutonium residues and scrub alloy were either analyzed in the Draft EIS or are composed of elements of alternatives analyzed in the Draft EIS. Nevertheless, since certain alternatives (as described in Section 1.3.1 above) were not presented to the public in the form in which they appear in this Final EIS, and in furtherance of public involvement in the NEPA process, DOE has decided to issue phased Records of Decision for this Final EIS.

The first Record of Decision will cover only those materials for which the preferred processing technology was analyzed in the Draft EIS, and for which any variances to safeguards termination limits discussed in the Draft EIS had already been granted. DOE plans to issue the first Record of Decision no sooner than 30 days after issuance of the Final EIS. The material categories to be covered by the first Record of Decision are as follows:

- Sand, slag, and crucible residues
- Direct oxide reduction salt residues (low plutonium concentration)
- Combustible residues
- Plutonium fluoride residues
- Ful Flo filter media residues
- Glass residues
- Graphite residues
- Inorganic (metal and other) residues
- Scrub alloy

The second Record of Decision will cover all of the remaining materials within the scope of the EIS. The material categories to be covered by the second Record of Decision are as follow:

- Incinerator ash residues

[4]*The term "processing" always includes repackaging. However, in some cases, repackaging may occur without additional processing.*

- Graphite fines residues
- Inorganic ash residues
- Molten salt extraction/electrorefining salt residues
- Direct oxide reduction salt residues (high plutonium concentration)
- High-efficiency particulate air (HEPA) filter media residues
- Sludge residues

Prior to issuing the second Record of Decision, DOE will hold a 45-day comment period for the purpose of receiving written comments from the public on the management of these remaining material categories. The 45-day comment period will begin when the Environmental Protection Agency publishes the *Federal Register* notice that announces the availability of this Final EIS.

At the end of the 45-day comment period, DOE will determine whether any comments have been received that raise issues that require further analysis. If no comments are received which require further analysis, DOE will issue a second Record of Decision that identifies its management decisions for the material categories. The Record of Decision will include DOE's responses to comments received from the public. If comments are received which require further action by DOE, DOE will determine and implement appropriate actions to address the comments and inform the public of the Department's decisions.

1.5 RELATIONSHIP TO OTHER NEPA DOCUMENTS AND REPORTS

Completed and ongoing NEPA documents and other reports that may relate to the scope of this EIS include the following:

1.5.1 Environmental Assessment, Finding of No Significant Impact, and Response to Comments—Solid Residue Treatment, Repackaging, and Storage (DOE 1996h, April 1996)

This Environmental Assessment addressed the stabilization of the plutonium residue inventory currently at Rocky Flats. It was developed in response to the Defense Nuclear Facilities Safety Board's Recommendation 94-1 (DNFSB 1994), which addressed safety issues associated with storage of residues. The Environmental Assessment described and analyzed the environmental effects of DOE's proposed action of treating and/or repackaging the residues and storing them at the site until their final disposition could be decided and implemented. The Environmental Assessment was the subject of a public comment period from March 5 to April 5, 1996. Based on the information and analyses in the Environmental Assessment, DOE determined that the proposed treatment, repackaging, and storage of solid residues at Rocky Flats did not constitute a major Federal action significantly affecting the quality of the human environment and issued a Finding of No Significant Impact for the proposed action on April 15, 1996. The actions analyzed and selected after the completion of this Environmental Assessment are included in the No Action Alternative.

1.5.2 Rocky Flats Site-Wide Environmental Impact Statement Notice of Intent (DOE 1994d, August 5, 1994)

This Notice announced DOE's intention to prepare a Site-Wide EIS for Rocky Flats. The Notice described the intended scope of the Site-Wide EIS as providing a basis for selection of a site-wide strategic approach for nuclear materials storage, waste management, cleanup, and economic conversion, as well as project-level decisions for management of nuclear materials, deactivation of Rocky Flats facilities, and decontamination and decommissioning of existing facilities. DOE has decided not to complete the Site-Wide EIS because the mission of the site has changed to cleanup in preparation for closure, and the environmental review for the cleanup will occur under the Comprehensive Environmental Response, Compensation, and Liability Act.

1.5.3 Interim Storage of Plutonium at the Rocky Flats Environmental Technology Site Environmental Impact Statement Notice of Intent (DOE 1996f, July 1996)

This Notice announced DOE's intention to prepare an EIS to evaluate the alternatives for providing safe interim storage of approximately 10 metric tons (11 tons) of plutonium at Rocky Flats pending implementation of decisions based on the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a). DOE has decided not to complete the Interim Storage EIS because of the decisions announced in the Record of Decision for the Storage and Disposition Programmatic Environmental Impact Statement (see discussion in Section 1.5.6).

1.5.4 Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement (DOE 1997c, September 1997)

This is the second Supplemental EIS (referred to as the WIPP SEIS-II) for the DOE Waste Isolation Pilot Plant (WIPP) project that is proposed for the disposal of transuranic waste. In the Record of Decision for the 1990 Supplemental EIS (DOE 1990), DOE indicated it would issue a second Supplemental EIS analyzing the impacts of processing and handling transuranic waste at the generator/storage sites and the long-term performance of WIPP before deciding whether to proceed to the WIPP disposal phase. DOE's proposed action is to dispose of transuranic waste at WIPP. The Rocky Flats plutonium residues are considered in the scope of the 1997 Supplemental EIS (DOE 1997b). The wastes from processing scrub alloy, to the extent they are similar to other transuranic waste from processing operations and do not exceed 25,000 cubic meters (880,000 cubic feet) in volume, are covered by the EIS. Direct disposal of scrub alloy at WIPP (without plutonium separation) is not covered by the WIPP Disposal Phase Supplemental EIS because their plutonium content was not considered in the WIPP disposal inventory. The Record of Decision for this EIS was published on January 23, 1998 (63 *Federal Register* 3624). This Record of Decision documented the Department's decision to implement the Proposed Action Alternative, contingent upon obtaining a Compliance Certification from the U.S. Environmental Protection Agency (EPA), which was issued on May 13, 1998 (EPA 1998). DOE has decided to open WIPP and dispose of 175,600 cubic meters of post-1970 defense transuranic waste, including the Rocky Flats residues and transuranic waste generated from processing the residues, as analyzed in the current EIS (DOE 1998e). Preparation of the transuranic waste (i.e., treatment, as necessary, including packaging) would be required to meet the WIPP Waste Acceptance Criteria.

1.5.5 Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (DOE 1997g, May 1997)

The *Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997g, May 1997) considered reasonable alternatives for the integrated treatment, storage, and/or disposal of DOE's low-level, low-level mixed, hazardous, transuranic, and high-level waste. The entire inventory of plutonium residues currently stored at Rocky Flats is included in the Waste Management Programmatic EIS under the assumption that it may be managed as transuranic waste. The Waste Management Programmatic EIS analyzes storage and treatment configurations for transuranic wastes (e.g., centralized, regionalized, and decentralized treatment and storage), including DOE's preferred strategies and the Rocky Flats plutonium residues. The Rocky Flats Plutonium Residues and Scrub Alloy EIS was prepared in coordination with the development of the Records of Decision for the Waste Management Programmatic EIS. The Record of Decision for treatment and storage of the transuranic waste was issued on January 23, 1998 (DOE 1998f). This Record of Decision was issued in conjunction with the WIPP Supplemental EIS Record of Decision (DOE 1998e). The Department's decision is to process and store transuranic waste on site prior to disposal.

1.5.6 Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Impact Statement (DOE 1996a, December 1996)

The *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Impact Statement* (DOE 1996a) analyzes the environmental impacts of alternatives considered for the long-term storage of weapons-usable plutonium and for the disposition of weapons-usable plutonium that has been declared surplus to national security needs. The Record of Decision (DOE 1997i) encompasses two categories of plutonium decisions: (1) the sites and facilities for the storage of nonsurplus plutonium and the storage of surplus plutonium pending disposition and (2) the programmatic strategy for disposition of surplus plutonium. This Record of Decision does not include the final selection of sites for plutonium disposition facilities, nor the extent to which the two plutonium disposition approaches (immobilization and mixed-oxide fuel) will be ultimately implemented. Those decisions will be based in part on the analysis in the Surplus Plutonium Disposition EIS (see Section 1.5.7). However, the Record of Decision states that DOE has narrowed the list of candidate sites for plutonium disposition.

1.5.7 Surplus Plutonium Disposition Draft Environmental Impact Statement (DOE 1998a, July 1998)

This Draft EIS analyzes the environmental impacts of alternatives considered for the disposition of U.S. weapons-usable surplus plutonium. The disposition strategy being considered by DOE is a twofold strategy involving (1) immobilization of surplus plutonium with glass or ceramic material for disposal in a monitored geologic repository pursuant to the Nuclear Waste Policy Act, as amended, and (2) burning some plutonium as mixed oxide fuel in existing, domestic, commercial reactors, with subsequent disposal of the spent fuel in a monitored geologic repository pursuant to the Nuclear Waste Policy Act, as amended. This EIS is tiered from the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a) and is based on a Record of Decision issued on January 14, 1997 (DOE 1997i). This Record of Decision (62 *Federal Register* 3014) announced DOE's intention to provide for safe and secure storage of weapons-usable fissile materials and DOE's strategy for disposition of surplus weapons-usable plutonium. The Record of Decision also indicated that plutonium metals and oxides currently stored at Rocky Flats would be moved. The plutonium pits (a nuclear weapons component) would be stored at the Pantex site. The non-pit metals and oxides would be moved to the Savannah River Site for storage if DOE decided that these materials should be immobilized at the Defense Waste Processing Facility at the Savannah River Site.

1.5.8 Final Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory (DOE 1992, August 1992)

This EIS analyzed the potential environmental impacts of the continued operation of Lawrence Livermore National Laboratory and Sandia National Laboratories in Livermore, California. The Lawrence Livermore National Laboratory Site-Wide EIS also analyzed the potential environmental impacts associated with a No Action Alternative to continue operations at FY 1992 funding levels without further growth, an alternative to modify operations to reduce adverse environmental impacts of operations or facilities, and an alternative involving the shutdown and commencement of decommissioning of the Laboratory. The Record of Decision for the Lawrence Livermore National Laboratory Site-Wide EIS (DOE 1993) announced DOE's decision to continue the operation of Lawrence Livermore National Laboratory and Sandia National Laboratories. Alternatives that involve treatment of the Rocky Flats plutonium residues at Lawrence Livermore National Laboratory were not analyzed in the Lawrence Livermore National Laboratory Site-Wide EIS.

1.5.9 Draft Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (DOE 1998b, April 1998)

The Los Alamos National Laboratory Site-Wide EIS (DOE 1998b) analyzes the level of operations and reasonably foreseeable activities that may take place at the Los Alamos National Laboratory during the next ten years. In that document, DOE identified and assessed four alternatives for the operation of the site: (1) No Action, (2) Expanded Operations (DOE's Preferred Alternative), (3) Reduced Operations, and (4) Greener. In the No Action Alternative, DOE would continue the historical mission support activities Los Alamos National Laboratory has conducted at planned operations levels. In the Expanded Operations Alternative, DOE would operate the site at the highest levels of activity currently foreseeable, including full implementation of the mission assignments from recent programmatic documents. Under the Reduced Operations Alternative, DOE would support the site at the minimum levels of activity necessary to maintain the capabilities to support the DOE mission in the near term. Under the Greener Alternative, DOE would operate the site to maximize operations in support of nonproliferation, basic science, materials science, and other nonweapons areas, while minimizing weapons activities. Alternatives analyzed in the Rocky Flats Plutonium Residues and Scrub Alloy EIS that involve processing of the Rocky Flats plutonium residues at Los Alamos National Laboratory are within the levels of operation addressed in the Los Alamos National Laboratory Site-Wide EIS.

1.5.10 Final Interim Management of Nuclear Materials Environmental Impact Statement (DOE 1995b, October 1995)

The Interim Management of Nuclear Materials EIS (DOE 1995b) analyzes the potential environmental impacts associated with alternatives for the management of a variety of nuclear materials at the Savannah River Site. This EIS also includes an evaluation of alternatives for processing approximately 1,000 kg (2,200 lb) of plutonium residues and scrub alloy currently stored at the Savannah River Site (see *Final Environmental Impact Statement, Interim Management of Nuclear Materials, Savannah River Site, Aiken, South Carolina*, Section 2.3.3, "Plutonium and Uranium Stored in Vaults"), much of which originated at Rocky Flats. Five Records of Decision, each covering different materials, have been issued for the Interim Management of Nuclear Materials EIS (DOE 1995a, DOE 1996i, DOE 1996c, DOE 1997b, and DOE 1997h). DOE decided to use a variety of technologies to stabilize these residues (repackage and heat treat, dissolve and stabilize) through the Canyon facilities to forms that meet DOE's storage criteria (DOE-STD-3013-94) (DOE 1994a) and to store the plutonium at the Savannah River Site (DOE 1995a).

1.5.11 Accelerating Cleanup: Paths to Closure (DOE 1998d, June 1998)

DOE's Office of Environmental Management is developing a strategy to accelerate site cleanup and to reduce long-term economic and environmental liabilities associated with the cleanup of sites and facilities no longer needed by the Department. The particular focus of this effort is on completing work at as many sites as possible by 2006. A discussion draft of *Accelerating Cleanup: Focus on 2006 Plan* was issued for public review and comment in June 1997 (DOE 1997f). The *Accelerating Cleanup: Paths to Closure*, issued in June 1998 (DOE 1998d), represented a significant refinement in the data quality and took into consideration comments received from stakeholders, regulators, and Tribal Nations during the "Discussion Draft" comment period. The *"Paths to Closure"* Plan is designed to give Tribal Nations, States, regulators, and other stakeholders an opportunity to participate in the development of the Environmental Management program, including helping to define innovative approaches to streamline cleanup and to save taxpayer dollars. The Plan is not a decision-making or budgetary document. It is designed, however, to be an integral part of the annual and multi-year DOE budget development process. Decisions on proposed actions to carry out the Environmental Management program, whether the actions are site-specific or national in scope, will be reported in the Plan. Appropriate NEPA reviews, such as preparation of this EIS, will be conducted prior to making any such decisions. The Office of Environmental Management's strategic goal of accomplishing as much work

as possible by 2006 will be one of the factors that will influence decisions being evaluated in this EIS. Subsequent versions of the Plan will reflect the decisions made as a result of this EIS.

1.5.12 DOE Nonproliferation Study (Pending)

The Department of Energy is preparing a report on the nuclear nonproliferation implications that under certain circumstances could be associated with chemical separation (a process that chemically extracts plutonium and uranium from other elements or compounds) of spent nuclear fuel of both domestic and foreign origin. This report, which DOE announced it would prepare in the *Record of Decision on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (61 Federal Register 25092, May 17, 1996), is intended to assist the Department of Energy in its ongoing efforts to manage nuclear materials under its jurisdiction in a manner consistent with broad United States nonproliferation and arms control objectives. These policies have been laid down by successive Presidents in a series of Presidential Decision Directives.

DOE believed at the time the Draft EIS was issued for public comment that the report would be completed in time to allow it to be considered, if appropriate, in conjunction with this EIS in deciding on the stabilization and disposition options for materials within the scope of this EIS. The current schedule for completion of the report, however, makes it clear that the report will not be completed in time to be available for consideration as intended.

The report focuses on potential nuclear nonproliferation benefits and vulnerabilities associated with various nuclear material handling technologies, including chemical separation, in instances other than to address health and safety vulnerabilities. All of the materials being considered in this EIS are covered by Defense Nuclear Facilities Safety Board Recommendation 94-1 and must be stabilized to address health and safety concerns. Any chemical separation operations performed on these materials would be conducted in the process of accomplishing this health and safety related stabilization, and to allow the materials to be disposed of, thus ending ongoing health and safety risks associated with their continued storage. Thus, although the results of the report will not be available for consideration in making decisions under this EIS, DOE believes that the concerns that led to the decision to prepare the report are being appropriately addressed by this EIS.

1.5.13 Savannah River Site Chemical Separations Facilities Multi-Year Plan (DOE 1997d, September 1997)

This document describes the results of an evaluation of various operational strategies for the nuclear materials chemical separation facilities (F- and H-Canyon facilities). The Canyon facilities, which have unique but complementary capabilities, were designed to reprocess, purify, and solidify large quantities of nuclear materials for the nuclear weapons program and civilian application. With the end of the Cold War, these facilities are no longer needed for the production of nuclear materials for the weapons program. Phaseout of these facilities includes the stabilization and processing of certain nuclear materials remaining from previous activities, including stabilization of limited quantities of plutonium materials from Rocky Flats. The strategy developed to phase out canyon operations allows DOE to conduct materials stabilization activities in facilities designed and currently configured to carry out such activities. This approach reduces construction/facility modification costs, enhances safety by keeping operations efficient and as simple as possible, and minimizes impacts to the operations workforce. This strategy permits the best utilization of available facilities, personnel, and resources to meet currently defined material processing requirements and provides sufficient capability to meet potential future processing missions.

1.5.14 Recommendation 94-1, Improved Schedule for Remediation in the Defense Nuclear Facilities Complex (DNFSB June 1994)

The halt in the production of nuclear weapons and the materials used in nuclear weapons froze the manufacturing pipeline in a state that the Board considered unsafe and in need of remediation. The Board issued Recommendation 94-1 on May 26, 1994, addressing the stabilization of these materials. DOE accepted the Board's Recommendation on August 31, 1994, and submitted its Implementation Plan in response to the recommendation on February 28, 1995. With respect to the plutonium residues at Rocky Flats, the Board recommended that preparations be expedited to process the containers of possibly unstable residues at Rocky Flats and to convert constituent plutonium to a form suitable for safe interim storage. Rocky Flats prepared an Environmental Assessment/Finding of No Significant Impact for stabilizing these materials in April 1996 (see Section 1.5.1, above). DOE subsequently determined that certain of these plutonium residues may require further processing prior to disposal or other disposition. Those materials are the subject of this Final EIS.

1.5.15 Plutonium Finishing Plant Stabilization Final Environmental Impact Statement (DOE 1996g, May 1996)

The actions evaluated in this EIS would stabilize Plutonium Finishing Plant Facility materials, including Hanford Site plutonium residues, that represented environmental, safety, or health vulnerabilities in their then-existing conditions. These vulnerabilities were the result of discontinuing nuclear materials production and processing operations following the end of the Cold War. At the time the Plutonium Finishing Plant Stabilization FEIS was prepared, DOE had already initiated programmatic environmental evaluations on the ultimate disposition of materials in the DOE complex that are surplus to national defense requirements. However, the implementation of decisions regarding ultimate disposition would take several years. In the interim, DOE wanted to eliminate vulnerabilities associated with certain current nuclear material storage configurations in order to protect the environment and the health and safety of workers and the public.

1.5.16 Rocky Flats Environmental Technology Site Cumulative Impacts Document (DOE 1997e, June 1997)

The Cumulative Impacts Document for the Rocky Flats Environmental Technology Site was prepared to provide an updated baseline of the cumulative impacts to the worker, public and environment due to Rocky Flats operations, activities, and environmental conditions in light of Rocky Flat's change in mission. Specifically, Rocky Flats has gone from production of nuclear weapons components to materials and waste management, accelerated cleanup, reuse and closure of the site. In addition, the document projects the cumulative impacts to the worker, public and environment due to implementing Rocky Flats' plans for achieving accelerated cleanup and closure of the site. The plans also include the planning assumptions, which are expected to reduce the overall site risk to the worker, public, and environment.

1.6 PUBLIC COMMENT PROCESS

The public has had two opportunities to comment on this EIS. The first opportunity was during the public scoping process, which was announced in the *Federal Register* Notice of Intent to prepare this EIS (November 19, 1996, 61 *Federal Register* 58866) (DOE 1996b). The second opportunity was during the public comment period for the Draft EIS, which was announced in the *Federal Register* Notice of Availability (DOE 1997a, EPA 1997) for the Draft EIS ("Notice of Availability of the *Draft Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site*," November 25, 1997, 62 *Federal Register* 62761).

During the scoping period, comments were received from about 30 individuals and organizations in the Rocky Flats and Savannah River Site areas. During the comment period for the Draft EIS, comments were received from 39 individuals and organizations from areas surrounding the Rocky Flats, Savannah River Site, and Los Alamos National Laboratory, as well as national organizations and individuals along potential transportation corridors. Most commentors provided their positions on one or more of the alternatives and most comments dealt with associated issues such as storage; ultimate disposition; proliferation; transportation; environmental, safety and health risks; and costs.

A summary of the public comment process and the public comments received during scoping and the Draft EIS public comment period is provided in Chapter 9 of this EIS. Chapter 9 also includes the specific public comments received on the Draft EIS, along with DOE's responses to those comments.

1.7 STRUCTURE OF THIS EIS

The remainder of this EIS is structured as follows:

- Chapter 2 describes the proposed action, alternatives for implementation of the proposed action, and a No Action Alternative.
- Chapter 3 describes the potentially affected environments at the sites that may be involved in implementation of the alternatives for management of the Rocky Flats plutonium residues and scrub alloy.
- Chapter 4 addresses the policy considerations and potential environmental impacts of the No Action Alternative and of each alternative for implementation of the proposed action.
- Chapter 5 describes the regulations applicable to actions that DOE might take under this EIS.
- Chapters 6, 7, and 8 contain reference information (the list of preparers, agencies consulted, and glossary).
- Chapter 9 describes the public participation process for this EIS and contains written public comments and a summary of issues raised during the public hearings, as well as DOE responses.
- The appendices to this document present descriptions of reference technologies and details and assumptions of the evaluations and analyses performed for this EIS. Appendix A includes the contractor's NEPA disclosure statement for preparation of the EIS.

1.8 REFERENCES

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2. ALTERNATIVES

2.1 OVERVIEW OF THE ALTERNATIVES

The U.S. Department of Energy (DOE) proposes to process certain plutonium residues and scrub alloy currently stored at the Rocky Flats Environmental Technology Site (Rocky Flats), if necessary, when those plutonium residues and scrub alloy have plutonium concentrations above safeguards termination limits (defined in box below). The Defense Nuclear Facilities Safety Board (the Board), in Recommendation 94-1 (DNFSB 1994), addressed health and safety concerns regarding various materials at Rocky Flats, including plutonium residues and scrub alloy. The Board concluded that hazards could arise from continued storage of these materials in their current form and recommended that they be stabilized. Although stabilization of the plutonium residues was addressed in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k), the processing analyzed in the Environmental Assessment would leave approximately 40 percent of the Rocky Flats plutonium residues (i.e., the plutonium residues covered by this Environmental Impact Statement [EIS]) in a form that could not be disposed of. In addition, the Environmental Assessment did not address stabilization of the scrub alloy. Since less than 10 percent of these Rocky Flats plutonium residues and none of the scrub alloy have been stabilized to date using the processes analyzed in the Rocky Flats Solid Residue Environmental Assessment, DOE considers it prudent to consider in this EIS processing alternatives that not only would stabilize the remaining plutonium residues to address the health and safety concerns raised by Board Recommendation 94-1, if necessary, but also would convert these residues into forms that would allow for their disposal or other disposition.

The plutonium residues and scrub alloy have been grouped into categories and subcategories that require similar processing technologies. Due to significant differences in the chemical and physical characteristics of the material in the various categories and in the methods required for processing them, DOE proposes to make processing or other decisions on each subcategory rather than on all of the materials in a category. The processing technologies being considered for each category are discussed in Sections 2.4.1 through 2.4.10 and in more detail in Appendix C. The environmental impacts from these alternatives are presented in Chapter 4 of this EIS.

Safeguards Termination Limits

"Safeguards" are part of the process of ensuring that unauthorized persons or organizations do not obtain materials (e.g., uranium or, for this EIS, plutonium) that could be used to manufacture nuclear weapons. Safeguards termination limits are limits on the maximum concentration of plutonium that may exist in a material without causing the material to be subject to the strict material control and accountability requirements applied under "safeguards" requirements. These concentration limits are established based on a determination of how low the plutonium concentration must be for any given material form to make the material unattractive as a source of plutonium.

The alternatives considered for this EIS are organized as follows:

- **Alternative 1 – No Action— Stabilize and Store—** Stabilize and repackage plutonium residues to prepare the material for interim storage as described in the *Environmental Assessment, Finding of No Significant Impact, and Response to Comments--Solid Residue Treatment, Repackaging, and Storage* (DOE 1996k) (the "Solid Residue Environmental Assessment"). Scrub alloy was not addressed in the Environmental Assessment. The No Action Alternative for scrub alloy is defined as continued storage at Rocky Flats with repackaging, as necessary. Since there is no basis for estimating how

long the stabilized residues and scrub alloy might have to remain in storage before a disposition mechanism would be identified, DOE analyzed in this EIS the annual impacts of such storage. The impacts of a 20-year storage period for the stabilized residues and scrub alloy are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. In addition to the storage analysis conducted in this EIS, the No Action Alternative included in the WIPP Supplemental EIS-II (DOE 1997a) presented a qualitative analysis of a much longer storage time. Under this alternative, the stabilization process would leave approximately 40 percent of the Rocky Flats plutonium residues and all of the Rocky Flats scrub alloy in a form that would not meet safeguards termination limits and, therefore, would not be eligible for disposal. Thus, while implementation of this alternative would address the most immediate health and safety concerns associated with near-term storage conditions, the indefinite storage of these materials would continue to present health and safety concerns that could only be eliminated by disposal or other disposition of the materials. All of the activities discussed under Alternative 1 would be performed at Rocky Flats.

- **Alternative 2 – Process without Plutonium Separation—**Processes that convert the material (including scrub alloy) into a form that meets safeguards termination limits for disposal at WIPP without removing plutonium from the material. All of the activities discussed under Alternative 2 would be performed at Rocky Flats.

- **Alternative 3 – Process with Plutonium Separation—**Processes that separate plutonium from the material and concentrate it so that the secondary waste meets the safeguards termination limits for disposal at WIPP while the separated and concentrated plutonium is placed in safe and secure storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1998). Any plutonium separated under any alternative analyzed in this EIS would be disposed of using the immobilization process. Under this alternative, the chemical separation of plutonium from the residues and scrub alloy would be conducted in the process of accomplishing the health and safety related stabilization required to comply with Defense Nuclear Facilities Safety Board Recommendation 94-1. Processing and storage activities under Alternative 3 could be performed at Rocky Flats, the Savannah River Site, or Los Alamos National Laboratory.

- **Alternative 4 – Combination of Processing Technologies—**DOE has combined certain elements of alternatives discussed in the Draft EIS, specifically elements of Alternative 1 (No Action—Stabilize and Store) and Alternative 2 (Process without Plutonium Separation) to form Alternative 4 (Combination of Processing Technologies). Development of a separate Alternative 4 allows the Department to more clearly address management of residues that have received a variance to safeguards termination limits (see Section 1.3.1).

  The need for this alternative became apparent to DOE after consideration of the results of further characterization that was performed on the residues after the Draft EIS was issued for public review. In particular, as Rocky Flats learned more about the nature of the plutonium residues, it became apparent that much of the residue inventory would not require further stabilization prior to repackaging (the final step of each processing option analyzed under Alternatives 1 and 2) to meet the WIPP waste acceptance criteria. Even where further stabilization might be required, the stabilization could be accomplished by rather straightforward means such as calcination, neutralization and drying, or filtration and drying (as analyzed under Alternatives 1 and 2 in the Draft EIS). Thus, if a means could be found to satisfy the safeguards termination limit requirements, affected residues could be prepared for disposal in WIPP with a minimum of exposure to the public and workers, generation of less transuranic waste, lower cost, and without separation of the plutonium in those residues.

Further consideration of the mechanisms available to protect the residues prior to the time when they could be disposed of in WIPP led DOE to the conclusion that the safeguards termination requirements need not be maintained in order to ensure that the residues are sufficiently protected to meet nuclear nonproliferation concerns. Thus, a variance to the safeguards termination limits was applied for and obtained.

Alternative 4 allows analysis of alternatives for management of those categories of residues for which a variance to safeguards termination limits has been granted, as described in Section 1.3.1. Certain residues, such as plutonium fluoride residues, Ful Flo filter media residues, and the scrub alloy, are not analyzed under this alternative because they had not been identified in the Draft EIS as a material for which a variance to the safeguards termination limits had been requested, and accordingly, application of a variance was not considered for the Final EIS.

For this EIS, the "proposed action" is to process the plutonium residues and scrub alloy, if necessary, to prepare them for disposal as transuranic waste or for other disposition. The proposed action could be accomplished by either Alternatives 2, 3, or 4, or by some combination of those alternatives for different material categories or portions of one or more material categories.

DOE initially considered processing plutonium residue categories and scrub alloy at Rocky Flats, the Savannah River Site, Los Alamos National Laboratory and Lawrence Livermore National Laboratory. However, after conducting the alternative technology screening and evaluation process implemented for this EIS, DOE determined that the two national laboratories have constraints that either precluded further consideration (Lawrence Livermore National Laboratory) or limit consideration to only three processes for pyrochemical salt residues (Los Alamos National Laboratory). As a result, DOE has limited its consideration of processing sites to Rocky Flats for processes with and without plutonium separation, the Savannah River Site for two processes with plutonium separation, and Los Alamos National Laboratory for three processes with plutonium separation. The applicability of the various sites to the alternatives analyzed in this EIS is portrayed in **Figure 2–1**, and discussed further in Section 2.9.2.

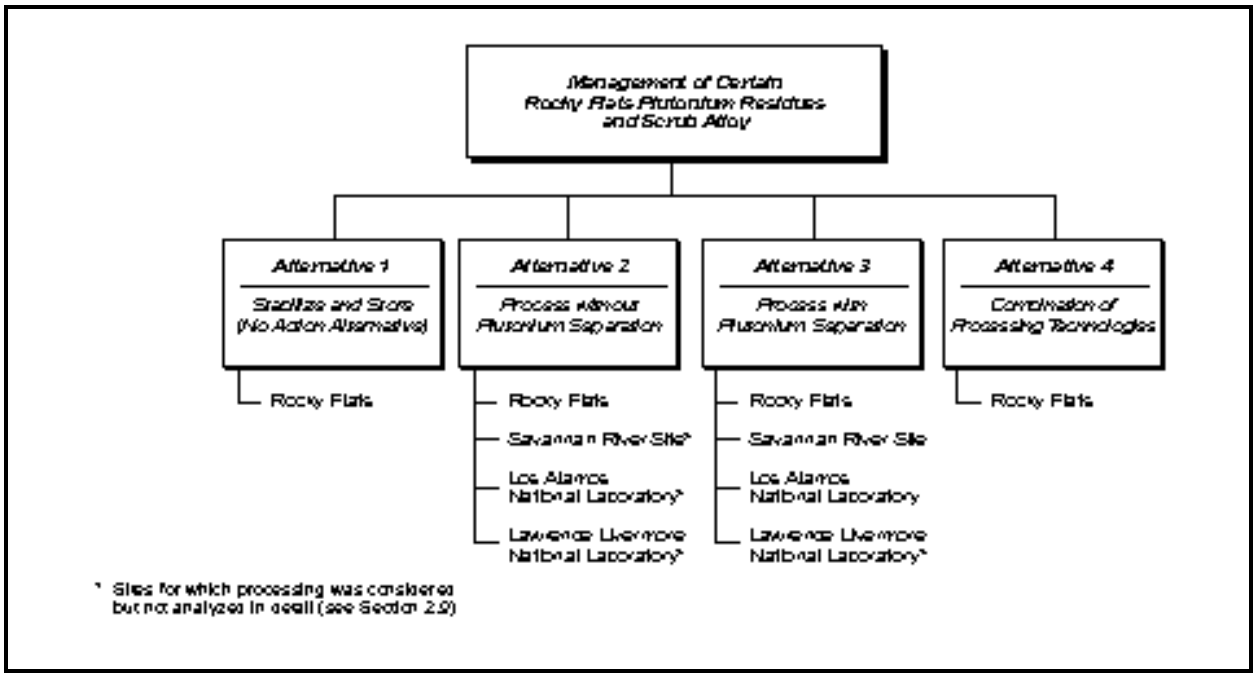

Figure 2–1 Plutonium Residue and Scrub Alloy Alternatives

Processing of the Rocky Flats plutonium residues and scrub alloy at Rocky Flats would be done primarily in two buildings at the site, Building 371 and Building 707. Building 371 would be used for processes that involve aqueous processing steps including mediated electrochemical oxidation, neutralization, sonic wash, cementation, acid dissolution, water leach, catalytic chemical oxidation, thermal desorption/steam passivation, and some blend down, cementing, and repackaging operations. Building 707 would be used for processes that are primarily thermal or physical operations including immobilization, pyro-oxidation, calcination, salt distillation, and some blend down and repackaging operations. Some processes could be done in either building. Rocky Flats would need to obtain an approved Resource Conservation and Recovery Act permit from the State of Colorado before they could process those residues with Resource Conservation and Recovery Act hazardous waste codes.

An issue has recently arisen concerning seismic events and Building 707. Analyses have determined that the return frequency for an earthquake that could cause collapse of Building 707 is 385 years. In addition, analyses have indicated that the collapse of Building 707 could collapse portions of Building 707A. The risk assessments for all processes in Buildings 707 and 707A have been revised in this Final EIS to reflect that an earthquake with a return frequency of 385 years will cause collapse of the buildings.

Several processes that involve separating plutonium (i.e., Alternative 3) are analyzed for the Savannah River Site and Los Alamos National Laboratory. These sites have unique facilities and/or processing expertise for separating plutonium from certain categories of plutonium residues and scrub alloy that are not available at Rocky Flats. It is important to be aware that some of these separation alternatives are proposed primarily due to health and safety concerns related to the increased worker radiation doses associated with the nonseparation alternatives. The Savannah River Site facilities for the separation of plutonium include the H-Canyon, HB-Line, F-Canyon, and the FB-Line. Use of these facilities, some of which are designed for remote operation, would result in lower worker radiation exposure than use of the glovebox facilities at Rocky Flats, low technical uncertainty, or low costs. For example, plutonium fluorides have the potential for an extremely high worker radiation dose due to a high neutron emission rate caused by interactions between alpha particles (generated by the radioactive decay of plutonium) and the fluorine nucleus. The plutonium separation process at the Savannah River Site (Purex) is performed in a remote-handling facility, which reduces worker dose substantially. Many of the pyrochemical salts also contain significant amounts of americium. Although the separation technologies for salts that could be processed at Los Alamos National Laboratory (salt distillation, acid dissolution/plutonium oxide recovery, and water leach) are not remote-handled, they consist of much shorter time exposures to the salts than the non-separation technology (blend-down) does, thereby reducing worker exposure substantially. Furthermore, the separation technologies would result in a smaller quantity of processed material requiring handling at the processing sites than those processes that stabilize the residues and scrub alloy through immobilization or blend down of those materials through the addition of inert or low plutonium content materials. This would further reduce worker exposure and generate less transuranic waste requiring disposal at WIPP. The reduced handling of this material at WIPP would decrease radiation exposure to the operational staff.

Los Alamos National Laboratory is considered a candidate site for three separation process technologies for materials considered in this EIS. Scientists at Los Alamos National Laboratory developed the salt distillation technology being considered for separation of plutonium oxide from certain pyrochemical salts. The site has the experience needed to apply this technology and, therefore, is included in this EIS for salt distillation. Los Alamos National Laboratory is also being considered for acid dissolution/plutonium oxide recovery and water leach of direct oxide reduction salts because of its experience with salt processing and Rocky Flats' limited capability for processing aqueous waste. Any processing activities at Los Alamos National Laboratory would be done in Building PF-4 at TA-55, the Los Alamos National Laboratory Plutonium Facility. Plutonium oxide separated from the residues would be stored at TA-55.

Many of the plutonium residues at Rocky Flats have been managed as hazardous waste under the Resource Conservation and Recovery Act, although some of this material may not fit the Resource Conservation and Recovery Act's definition of hazardous waste. Rocky Flats is in the process of further characterizing these materials to determine whether they are hazardous wastes. In addition, preprocessing at Rocky Flats would remove certain hazardous characteristics prior to shipment to another site. Hazardous wastes would not be sent to another site for processing.

In Sections 2.4 and 2.5.2, DOE has identified its preferred processing technologies for each of the Rocky Flats plutonium residue and scrub alloy material categories and subcategories. These preferences are based on a combination of factors including process technical maturity, cost, and schedule. The rationale for the preference for each material is included in the discussions about those materials in the appropriate subsections of Section 2.4.

2.2 QUANTITY AND CHARACTERISTICS OF PLUTONIUM RESIDUES AND SCRUB ALLOY AT ROCKY FLATS

Rocky Flats currently has in storage approximately 106,600 kilograms (kg) (235,000 pounds [lb]) of plutonium residues and 700 kg (1,540 lb) of scrub alloy containing approximately 3,000 kg and 200 kg (6,600 lb and 440 lb) of plutonium, respectively. DOE has determined that approximately 40 percent of the residues and 100 percent of the scrub alloy have plutonium concentrations above the safeguards termination limits.

The safeguards termination limits (see Table B–1, page B-5) specify the maximum concentrations of plutonium that may exist in plutonium-bearing materials below which the materials are not subject to the strict material control and accountability requirements applied under "safeguards" requirements. The concentration limits are determined by the difficulty in recovering plutonium from the material and are higher for plutonium embedded in solids such as glass or cement than for materials from which the plutonium is easily recoverable. The plutonium residues and scrub alloy that exceed the safeguards termination limits may require further processing beyond that described in the *Solid Residue Environmental Assessment (DOE 1996k)*, to allow for disposal or other disposition unless they have been granted a variance from safeguards termination limits. These residues and scrub alloy are the principal subject of this EIS.

The plutonium residue and scrub alloy materials subject to this EIS were described in the Notice of Intent (DOE 1996c). They have been grouped into material categories that would undergo the same set of processing technologies.

DOE recognizes that materials within these categories do not have a uniform content and that some of the processing technologies assumed for a broad material category may not be appropriate for all of the materials included in that category. DOE also recognizes that, when the storage containers are opened, the quantities and characteristics of the plutonium residues and scrub alloy may vary somewhat from those assumed in this analysis. The analyses in this EIS are based on the best knowledge of the amounts and characteristics of the plutonium residues and scrub alloy available at the time the EIS was prepared. The analysis methodologies and assumptions used in this EIS are conservative and would accommodate uncertainties in the quantities of materials to be processed. The plutonium residues and scrub alloy are briefly discussed in Chapter 1 and described in detail in Appendix B of this EIS. The five Notice of Intent categories are as follows:

- **Ash Residues—**Rocky Flats' total ash residue category consists of approximately 27,900 kg (61,500 lb) of material containing approximately 1,250 kg (2,760 lb) of plutonium in three basic groups: (1) incinerator ash, firebrick heels and fines, and soot; (2) sand, slag, and crucible; and (3) graphite fines. Approximately 72 percent of the ash residue inventory (approximately 20,060 kg or 44,200 lb) would

require additional processing to meet the requirements for disposal at WIPP or other disposition alternatives.

- **Salt Residues**—Rocky Flats' total salt residue category consists of about 16,000 kg (35,300 lb) of material that contains approximately 1,000 kg (2,200 lb) of plutonium and can be subdivided into three groups: electrorefining salts, molten salt extraction salts, and direct oxide reduction salts. These salts contain sodium chloride, potassium chloride, magnesium chloride, calcium chloride, zinc chloride, and cesium chloride. Approximately 93 percent of the salt residue inventory (approximately 14,900 kg or 32,800 lb) would require additional processing to meet the requirements for disposal in WIPP or other disposition and are covered by this EIS.

- **Wet Residues**—Rocky Flats' total wet residues consist of approximately 16,500 kg (36,400 lb) of material containing approximately 340 kg (750 lb) of plutonium and are composed of a disparate assembly of materials such as wet (aqueous- and organic-contaminated) combustibles, plutonium fluorides, high-efficiency particulate air filter media, sludges, greases/oil, and Raschig (glass) rings. Approximately 26 percent of the wet residue inventory (approximately 4,300 kg or 9,500 lb) would require additional processing to meet the requirements for disposal at WIPP or other disposition alternatives.

- **Direct Repackage Residues**—Rocky Flats' direct repackage residue category consists of about 39,300 kg (86,600 lb) of material, containing about 340 kg (750 lb) of plutonium and comprises those plutonium residues that are considered to be stable and do not require processing. The residues consist of such materials as paper, rags, cloth, plastic, personal protective equipment, and gaskets. Approximately 7.8 percent of the direct repackage residue (approximately 2,900 kg or 6,400 lb) would require additional processing to meet the requirements for disposal in WIPP or other disposition and are covered by this EIS.

- **Scrub Alloy**—Scrub alloy is predominantly a magnesium/aluminum/americium/plutonium metal alloy that was created as an interim product in plutonium recovery. Scrub alloy is not considered a plutonium residue. Rocky Flats' entire scrub alloy inventory of approximately 700 kg (1,540 lb), containing approximately 200 kg (440 lb) of plutonium, will require processing to put it in a form that would meet the requirements for disposition.

For the purpose of calculating the environmental impacts, DOE has regrouped the plutonium residues and scrub alloy into new categories that require similar processing technologies. The management options for each category are described in Section 2.4. The 10 material categories used in this EIS are as follows:

1. Ash Residues
2. Pyrochemical Salt Residues
3. Combustible Residues
4. Plutonium Fluoride Residues
5. Filter Media Residues
6. Sludge Residues
7. Glass Residues
8. Graphite Residues
9. Inorganic (Metal and Others) Residues
10. Scrub Alloy

Table 2–1 shows how the 10 categories used in this EIS correspond to the 5 previously described residue and scrub alloy material categories from the Notice of Intent (DOE 1996c).

2.3 PROCESSING TECHNOLOGIES ASSESSED IN THIS EIS

The plutonium residues and scrub alloy processing technologies evaluated in this EIS were identified through a process that included review of technical reports and evaluation by technical experts from DOE Headquarters, Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory. These experts also

evaluated the feasibility of implementing the technologies at the DOE sites under consideration. This process is described in more detail in Section 2.9 and in Appendix C. The following documents were among those reviewed:

- *Environmental Assessment, Finding of No Significant Impact, and Response to Comments — Solid Residue Treatment, Repackaging, and Storage* (DOE 1996k).

- *Rocky Flats Environmental Technology Site: Direct Disposal Trade Study for Plutonium-Bearing Residues* (DOE 1995a).

- A series of trade studies on specific material categories by the DOE Nuclear Material Stabilization Task Group:

  - *Plutonium Combustibles Trade Study* (DOE 1996b)
  - *Plutonium Salts Trade Study* (DOE 1996n)
  - *Plutonium Sand, Slag, and Crucible Trade Study* (DOE 1997f)
  - *Ash Residues End-State Trade Study* (DOE 1996e)
  - *Plutonium Scrub Alloy Trade Study* (DOE 1996m).

- *Residue Program Rebaselining: Phase I Recommendation for Rebaselining Salts, SS&C, and Graphite Fines* (Ferrera 1996) (the Rocky Flats Rebaselining Study).

- *Residue Program Rebaselining: Phase II Recommendation for Rebaselining Ash, Combustibles, Fluorides, Sludges, Glass, and Firebrick and Inorganics* (Gilmartin 1997).

Table 2–1 Comparison of Plutonium Residue and Scrub Alloy Material Categories

Notice of Intent Categories	*EIS Categories*
Ash Residues - Incinerator Ash, Firebrick Heels and Fines, and Soot - Sand, Slag, and Crucible - Graphite Fines	**(#1) Ash Residues (20,060 kg [44,200 lb]** containing 1,160 kg [2,560 lb] of plutonium) -Incinerator Ash and Ash Heels, and Firebrick Fines [a] -Sand, Slag, and Crucible -Graphite Fines [a] - Inorganic Ash [a]
Salt Residues - Electrorefining Salts - Molten Salt Extraction Salts - Direct Oxide Reduction Salts	**(#2) Pyrochemical Salt Residues (14,900 kg [32,800 lb]** containing 1,000 kg [2,200 lb] of plutonium) -Electrorefining Salts [a] -Molten Salt Extraction Salts [a] -Direct Oxide Reduction Salts [b]
Wet Residues - Wet Combustibles (partial)	**(#3) Combustible Residues (partial)** [a] -Aqueous/Organic-Contaminated Combustibles (685 kg [1,500 lb] containing 12 kg [26 lb] of plutonium)
- Plutonium Fluoride	**(#4) Plutonium Fluoride Residues (315 kg [690 lb]** containing 142 kg [313 lb] of plutonium)
- Wet Combustibles (partial)	**(#5) Filter Media Residues [b] (2,630 kg [5,800 lb]** containing 112 kg [250 lb] of plutonium
- Sludge - Greases/Oily Sludge	**(#6) Sludge Residues (620 kg [1,370 lb]** containing 27 kg [60 lb] of plutonium) -Sludge [a] -Greases/Oily Sludge [a]
- Raschig Rings	**(#7) Glass Residues (partial)** [a] -Raschig Rings (7.3 kg [16 lb] containing 1 kg [2.2 lb] of plutonium)
Direct Repackage Residues - Glass	**(#7) Glass Residues (partial)** [a] -Other Glass (126 kg, [280 lb] containing 4 kg [8.8 lb] of plutonium)

Notice of Intent Categories	*EIS Categories*
- Dry Combustibles	**(#3) Combustible Residues (partial)** [a] -Dry Combustibles (455 kg, [1,000 lb] containing 9 kg [20 lb] of plutonium)
- Graphite, Firebrick	**(#8) Graphite Residues** [a] **(1,880 kg [4,150lb]** containing 97 kg [214 lb] of plutonium) -Graphite, Firebrick
- Miscellaneous	**(#9) Inorganic Residues (Metal and Others)** [a] **(460 kg [1,000 lb]** containing 18 kg [40 lb] of plutonium) -Miscellaneous
Scrub Alloy	**(#10) Scrub Alloy (700 kg [1,540 lb]** containing 200 kg [440 lb] of plutonium)

[a] A variance to safeguards termination limits may be applied to these categories, which would allow for disposal at WIPP.
[b] A variance to safeguards termination limits may be applied to a portion of these categories, which would allow for disposal at WIPP.

Based on information in these documents, a set of potential processing technologies was identified for each material category.

With a few exceptions, each material category considered in this EIS was evaluated using the processes included in the No Action Alternative (i.e., stabilization and repackaging of residues that were considered in the Solid Residue Environmental Assessment), one or more processes that do not include separation of plutonium from the material, and one or more processes that include separation of plutonium from the material. In addition, most materials categories were also evaluated using a combination of elements from the No Action Alternative (i.e., stabilization and repackaging), processing without plutonium separation (i.e., blending to less than 10 percent plutonium), and application of a variance to the safeguards termination limits for the materials. Materials that were not evaluated for processes with plutonium separation were inorganic ash residues and sludge residues in Item Description Codes (IDCs) 089, 099, and 332. Materials that were not considered for the combination of processing technologies were plutonium fluoride residues, Ful Flo filter media residues, and scrub alloy.[1]

Because of the significant differences in the chemical and physical characteristics of the materials in various categories and in the technologies required for processing them, DOE proposes to make processing decisions on each subcategory rather than on the material categories. The technologies that apply to each of the categories are based on the best knowledge of the specifics of the processing options available at the time the EIS was prepared. These technologies are listed in **Figure 2–2** and are defined in the following sections; they are described in greater detail in Sections 2.4.1 through 2.4.10 and in Appendix C.

2.3.1 Processes Included in No Action—Stabilize and Store (Alternative 1)

The stabilization technologies analyzed for the No Action Alternative are those that were analyzed in the Solid Residue Environmental Assessment (DOE 1996k). Scrub alloy was not addressed in that Environmental Assessment. In this EIS, the No Action Alternative for scrub alloy is defined as continued storage at Rocky Flats, with repackaging as necessary. Since there is no basis for estimating how long the plutonium residues and scrub alloy might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. A material may be subjected to more than one technology conducted in series. For example,

[1] *Use of the Combination of Processing Technologies Alternative is evaluated for processing the entire inventory of direct oxide recovery salts due to uncertainties in the exact amount of material that would be processed under this alternative.*

the No Action Alternative for incinerator ash is calcination followed by cementation. Some subgroups may be subject to several different processes. All processing would take place at Rocky Flats.

2.3.2 Process without Plutonium Separation (Alternative 2)

The technologies analyzed in this EIS for processing without plutonium separation include those identified in the Plutonium Residues Trade Studies or the Rocky Flats Rebaselining Study (Ferrera 1996 and Gilmartin 1997) as mature enough for implementation by 1998-2004. A new technology, cold ceramification, has been added to the Final EIS for incinerator ash residues. Each material category in the EIS is evaluated using one or more technologies that do not involve separating plutonium from the material. All such processing would take place at Rocky Flats.

■ = Preferred processing option ▪ = Other processing options analyzed

Notes: IDC = Item Description Code; ER = Electrorefining; HS&T = Molten Salt Extraction; DOR = Direct Oxide Reduction

[a] There are no preferred processing technologies for processing high plutonium concentration DOR salt residues. The rationale for having no preferred processing technologies is given in Section 2.4.2.

[b] Alternative 4 may involve blending high plutonium concentration materials with dilution low plutonium concentration materials to achieve plutonium concentrations below 10 percent.

Figure 2–2 Processing Technologies Assessed for Each Plutonium Residue and Scrub Alloy Category

2.3.3 Process with Plutonium Separation (Alternative 3)

The technologies analyzed in this EIS for processing with plutonium separation are those that were identified in the Plutonium Residues Trade Studies or the Rocky Flats Rebaselining Study (Ferrera 1996) as mature enough for implementation within the next several years. Each material category in the EIS, except for inorganic ash residues and sludge residues in IDCs 089, 099, and 332 (for which no separation technology is available), is evaluated using one or more technologies that involve separating plutonium from the material. In addition, this EIS discusses the applicability of the technologies at each of the three candidate sites—Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory. A new technology, acid dissolution/ plutonium oxide recovery at Los Alamos National Laboratory, has been added to the Final EIS for direct oxide reduction salt residues.

2.3.4 Combination of Processing Technologies (Alternative 4)

The stabilization, blending and repackaging technologies analyzed for Alternative 4 (Combination of Processing Technologies) are similar to technologies that were analyzed for Alternative 1 (No Action Alternative) and Alternative 2 (Processing without Plutonium Separation). Rocky Flats has determined that the high-efficiency particulate air filter media (except Item Description Code [IDC] 338) are not acid-contaminated and do not have to be neutralized and dried, and the sludge residues (with IDCs 089, 099, and 332) are not wet and do not need to be filtered and dried. These residues would be repackaged instead. Any material that is above 10 percent plutonium concentration would be blended with low plutonium concentration material from the same IDC or with inert material to reach the 10 percent limit.

During characterization of the ash and pyrochemical salt residues since the Notice of Intent to prepare this EIS, Rocky Flats determined that some of these materials do not need to be stabilized for interim storage. Material that is above 10 percent plutonium concentration would be blended with low plutonium concentration material from the same IDC or with other inert material to reach the 10 percent plutonium concentration limit. The materials would then be repacked into pipe components, which would then be placed in drums, and stored, pending shipment to WIPP for disposal as transuranic waste. All processing for Alternative 4 would take place at Rocky Flats.

2.4 MANAGEMENT ALTERNATIVES FOR EACH MATERIAL CATEGORY

The following sections cover the processing technologies and sites considered for each material category of the Rocky Flats plutonium residues and scrub alloy. Sections 2.4.1 through 2.4.10 contain brief descriptions of the material categories to be discussed, as well as descriptions of the technologies analyzed for Alternative 1 (the No Action—Stabilize and Store), Alternative 2 (Process without Plutonium Separation), Alternative 3 (Process with Plutonium Separation), and Alternative 4 (Combination of Processing Technologies). More detailed descriptions of the material categories and processing technologies may be found in Appendices B and C, respectively. The impacts are discussed in Chapter 4 and Appendix D. Figures 2–3 through 2–12 contain flow diagrams of the processing technologies for each material type. The preferred processing technologies are presented in bold.

2.4.1 Management of Ash Residues

Ash residues at Rocky Flats include materials in four subcategories: (1) incinerator ash (including ash heels and firebrick fines); (2) sand, slag, and crucible; (3) graphite fines; and (4) inorganic ash. The last category includes chloride-contaminated magnesium oxide crucible and oxide from ventilation ducts.

Some of the ash residues have been assigned hazardous waste codes under the Resource Conservation and Recovery Act. A description of hazardous waste codes is provided in Table B–4 of Appendix B.

The total quantity of ash residues at Rocky Flats subject to processing is approximately 20,060 kg (44,200 lb) and includes approximately 1,160 kg (2,560 lb) of plutonium. The technology/site options analyzed for ash residues are shown in **Figure 2–3**. The impacts associated with the management of ash residues are presented in Tables 2-8 through 2-11 and in Section 4.2.

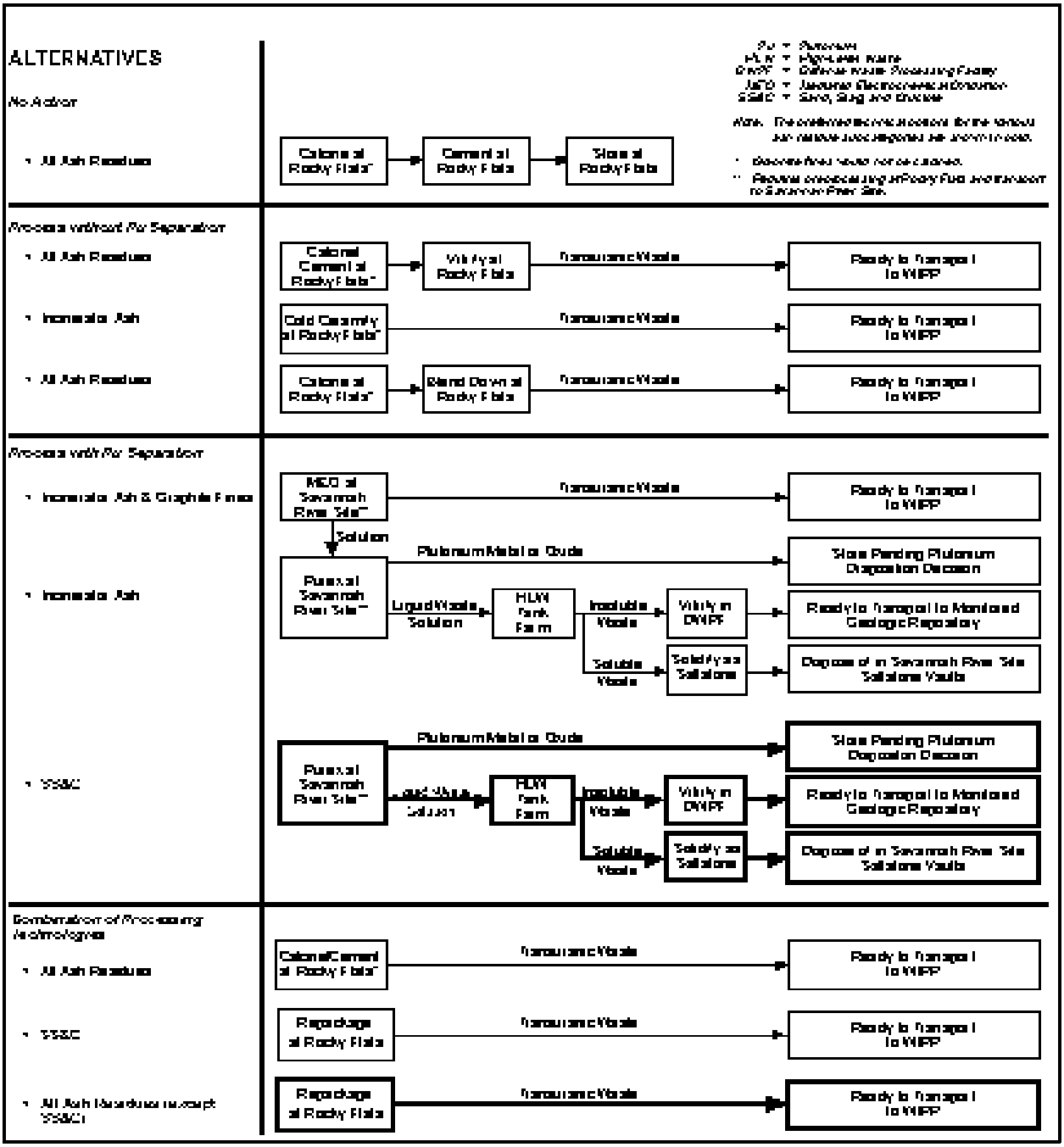

Figure 2–3 Processing Technologies for Ash Residues

DOE has identified repackage under Alternative 4 as the preferred processing technology for incinerator ash, graphite fines, and inorganic ash residues. Further characterization of these materials has shown that they do not need to be stabilized. Repackaging these materials into pipe components prior to shipment to WIPP would provide an additional measure of safety with regard to their storage, handling, transportation, and disposal.

The preferred processing technology for sand, slag, and crucible residues is preprocessing at Rocky Flats and the Purex process at the Savannah River Site (Alternative 3). This preference is based on two factors: the availability of the Savannah River Site canyons for processing the materials and possible delays in the ability to characterize this material for disposal at WIPP before the window of opportunity for processing in the canyons closes. To confirm the viability of repackaging (Alternative 4) for Rocky Flats sand, slag, and crucible, Rocky Flats would probably need to take three actions which would not be completed until at least October 1999:

- Complete additional characterization of the residue to establish a 95 percent confidence limit that no more than 5 percent could be pyrophoric.

- Obtain a modification of the WIPP TRUCON Shipping Code for sand, slag, and crucible to change the allowable passivated calcium metal content from a trace (less than 1 percent) to a minor (1-10 percent) constituent in the chemical capability code. This change could be submitted to the Nuclear Regulatory Commission in September 1998 and would require 6 to 12 months for approval.

- Obtain WIPP certification. This might require about one year.

The Savannah River Site has existing quantities of sand, slag, and crucible remaining from its own operations that will be processed in its separation canyons. The sand, slag, and crucible residues from Rocky Flats can be processed in the Savannah River Site Canyons without extending the planned operations of these facilities. The time period available for processing sand, slag, and crucible is limited and would pass prior to the earliest date that Rocky Flats could send repackaged sand, slag, and crucible to WIPP for disposal. DOE believes that it would be imprudent to forego the opportunity to process the sand, slag, and crucible at the Savannah River Site, given the uncertainties associated with repackaging and disposal at WIPP.

2.4.1.1 Alternative 1—No Action—Stabilize and Store

- **Calcination/Cementation—**The methodologies for stabilizing plutonium residues to meet Rocky Flats' interim safe storage criteria[2] are described in detail in the Solid Residue Environmental Assessment (DOE 1996k). The ash residues would be size-reduced by crushing and calcining and then cementing or repackaging to immobilize respirable fines. The containers of cemented and/or repackaged residues would then be placed inside 208-liter (L) (55-gal) drums in a configuration that meets the interim safe storage criteria. These drums would be stored at Rocky Flats pending final disposition. As there is no basis for estimating how long the stabilized residue might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. All stabilization activities would take place in Building 707 or Building 371. Calcination of powdered or granular materials in muffle furnaces[3] is considered to be a proven technology. Cementation of materials to immobilize fines and to form an

[2]The interim safe storage criteria were developed in response to the Defense Nuclear Facilities Safety Board's Recommendation 94-1 (DNFSB 1994).

[3]Muffle furnaces are small (approximately 1 cubic foot), oven-like, electrically heated units; they are lined with refractory material, and they can be used to heat material placed onto trays inserted into the unit.

acceptable solid is also considered to be a proven technology, although optimization studies are routinely performed to improve specific characteristics.

2.4.1.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three processing technologies that do not involve plutonium separation for ash residues: vitrification, cold ceramification, and blend down with inert or low-plutonium content materials to meet the safeguards termination limits. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

- **Vitrification—**Vitrification (encapsulation in a glass matrix) was used as the technology for immobilization in conducting the impact analysis of ash residues. Vitrification (also discussed in Appendix C) is being considered at Rocky Flats for stabilization of some materials in its waste backlog and is considered to be a proven technology for most residue types to which it may be applied. A technical development program is underway for vitrification of ash residues. Vitrification is being evaluated for the plutonium residues that do not meet the safeguards termination limits in their current form. Activities are underway to optimize the process and reduce the steps necessary to achieve an acceptable waste form. In the Rocky Flats process, ash residues would be placed in Module E, Building 707. There the ash would be unpacked, sorted, size-reduced (as necessary), and measured into 8.2-L (2.2-gal) cans. The amount of ash added to the cans would be limited to 83.5 grams (g) (0.18 lb) plutonium per can. Ash residues would be calcined before being vitrified to prevent off-gases from combusting during vitrification. Glass frit would be added until the resulting material falls below the safeguards termination limits for vitrified material. The mixture would then be melted at 700 to 1,300 degrees Celsius (°C) (1,290 to 2,370 degrees Fahrenheit (°F)) to be encapsulated in glass. After cooling, the vitrified ash would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

- **Cold Ceramification—**Cold ceramification is a process that would stabilize residues or other materials by converting contaminated materials into chemically bonded phosphate ceramics. The residue material would be mixed with reagents such as magnesium oxide and monopotassium phosphate or phosphoric acid to produce low temperature chemical reactions that would yield a ceramic material in which the hazardous and radioactive constituents would be chemically stabilized, physically resistant, impermeable, and strong. Cold ceramification is being considered by Rocky Flats for its incinerator ash residues. Although the process is still under development, it is similar to the cementation process currently in use at Rocky Flats and uses similar equipment. In the Rocky Flats process, ash residues would be placed in a glovebox in Building 707. There the ash would be unpacked, sorted, sized-reduced (as necessary), and measured into 6-L (1.6-gal) cans. Each container would be filled to contain about 167 g (0.36 lb) of plutonium. Then magnesium oxide and monopotassium phosphate would be blended into the container with the residue. Measured quantities of water then would be blended into the containers and the material would be mixed until it thickens and appears to be homogeneous. Next, the container would be moved from the mixing station into a set of curing gloveboxes and set aside for approximately 24 hours of curing. After curing, the ceramified material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

- **Blend Down—**Some material may have a plutonium concentration only slightly greater than the safeguards termination limits, or may consist of only a small quantity of material that is above the safeguards termination limits. In these circumstances, the plutonium residue may be blended down by adding material with a plutonium concentration below the safeguards termination limit so that the material may be disposed of at WIPP without further processing. The ash residue would be moved to Module B, Building 707, and bagged into the glovebox. Building 371 is under consideration as an alternative location for the blend down

process. There residues would be unpacked, size-reduced as necessary, measured into batches, and calcined at 900°C (1,650°F). The calcination would oxidize any carbon or organic compounds present to carbon dioxide and would also eliminate water, or the residue could be blended with an inert material such as uranium oxide, salt, or magnesium oxide to form a mixture that meets plutonium safeguards termination limits. Calcination and blending are considered to be proven technologies.

Incinerator ash and graphite fines would be measured into batches with 83.5 g (0.18 lb) or less of plutonium, allowing for maximum packaging flexibility during the final packaging step. The sand, slag, and crucible residues and the inorganic ash residues would be measured into batches with about 18 g (0.04 lb) of plutonium because of the high ratio of dilutent to residue matrix required. After processing, the batches would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.1.3 Alternative 3—Process with Plutonium Separation

DOE analyzed two processes for separation of plutonium from the ash residue: the Purex process and mediated electrochemical oxidation. Quantitative analyses of these technologies were conducted for the Savannah River Site. Both of these technologies involve acid dissolution of the ash followed by conversion to plutonium metal or oxide. In the Purex process, all of the plutonium in the incinerator ash and sand, slag, and crucible residues would be converted to plutonium metal or oxide. In the mediated electrochemical oxidation process, all the ash residues (except sand, slag, and crucible; and inorganic ash) would be converted to plutonium metal or oxide. Neither the Purex nor mediated electrochemical oxidation processes can separate plutonium from the inorganic ash residues. Any plutonium separated under this alternative would be disposed of using an immobilization process.

Ash stabilization activities for incinerator ash and graphite fines would be conducted in Module E, Building 707, at Rocky Flats before shipment to the Savannah River Site. The residues requiring calcination before shipment would be unpacked in the glovebox, size-reduced as necessary, measured into batches, and calcined at 900°C (1,650°F) for two hours. The calcination would oxidize carbon and organics to carbon dioxide and would eliminate water to provide a material that would meet shipping criteria.

The existing equipment used in the Purex process at the Savannah River Site cannot process incinerator ash in its present form because the ash is not readily soluble in nitric acid. If mediated electrochemical oxidation was not used to dissolve plutonium, the incinerator ash would first be fused with an oxidant, such as sodium peroxide to convert it to a more soluble form before shipment to the Savannah River Site. The fusion process would be additional to the calcination step in the preprocessing of incinerator ash.

- **Mediated Electrochemical Oxidation at the Savannah River Site—**At the Savannah River Site, incinerator ash and graphite fines residues would be received at the Plutonium Storage Facility for interim storage. The ash residues would then be transferred to the New Special Recovery facility and dissolved using newly installed dissolvers that use the silver(II) ion to dissolve the normally intractable plutonium in the ash. These dissolvers were developed by Pacific Northwest National Laboratory, Lawrence Livermore National Laboratory, and the Savannah River Site for this purpose and are used in France to recover plutonium. The New Special Recovery facility would have to be modified for silver(II) electrochemical dissolvers. The process would also require minimal operation of the F-Canyon. An equivalent option would be to install the silver dissolver in the HB-Line and use the H-Canyon/HB-Line facilities. The mediated electrochemical oxidation process is considered to be a well demonstrated technology, although it has not yet been used in production operations in DOE facilities.

Once the plutonium was in solution, any undissolved material would be filtered out, packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The remaining plutonium-bearing solution would be transferred to the F-Canyon (or H-Canyon) where it would be processed through the existing Purex system to separate plutonium from waste materials in the solution. The waste fraction would be transferred to the high-level waste system, where it would be added to the materials in the high-level waste tanks. The insoluble solids would be vitrified with high-level waste in the Defense Waste Processing Facility, and the residual liquids would be solidified as saltstone. The plutonium-bearing fraction would be transferred to the FB-Line (HB-Line), where it would be precipitated as plutonium trifluoride and reduced with calcium metal to plutonium metal. [If the material is processed through the HB-Line, the final product would be plutonium oxide.] The plutonium would be thermally stabilized and packaged to meet DOE-STD-3013-96 (DOE 1996f), and placed in interim storage in the FB-Line vaults (or in the Actinide Packaging and Storage Facility, when completed), pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement (DOE 1997c).

- **Purex Process—**At the Savannah River Site, incinerator ash and sand, slag, and crucible residues would be received at the 235-F facility for storage. The residues would then be transferred to a Canyon facility, where they would be dissolved in nitric acid. The solution would then be separated into two fractions, a waste solution and a plutonium-bearing solution. The waste fraction would be transferred to the high-level waste system, where it would be added to the materials in the high-level waste tanks. The solids would be vitrified with high-level waste in the Defense Waste Processing Facility, and the residual liquids would be solidified as saltstone. The plutonium-bearing fraction would be transferred to a finishing line (FB/HB), where it would be precipitated and converted to a stable oxide or metal. The plutonium would be thermally stabilized, packaged to meet DOE-STD-3013-96 (DOE 1996f), and placed in interim storage in the FB-Line vaults (or in the Actinide Packaging and Storage Facility, when completed), pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). The Purex process at the Savannah River Site is considered to be a proven technology.

2.4.1.4 Alternative 4—Combination of Processing Technologies

DOE analyzed two processing technologies for ash residues under this alternative: calcination/cementation and repackaging.

- **Calcination/Cementation—**DOE would implement the same stabilization technology described under the No Action Alternative in Section 2.4.1.1, if necessary, and would apply a safeguards termination limits variance based on a maximum plutonium concentration of 10 percent plutonium. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material. After processing, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Repackaging—**DOE would apply a safeguards termination limit variance for materials not requiring stabilization (as determined through characterization). A variance would be based on a maximum plutonium concentration of 10 percent plutonium. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material. The materials would then be repackaged into containers and place into pipe components (see Section 2.6.1), which would then be placed into drums. The drums would be placed in short-term storage pending disposition at WIPP as transuranic waste.

2.4.2 Management of Pyrochemical Salt Residues

The primary subcategories of pyrochemical salt residues at Rocky Flats are electrorefining salt residues, molten salt extraction salt residues, and direct oxide reduction salt residues. The first two categories consist primarily of a sodium chloride/potassium chloride matrix and are contaminated with plutonium chloride, americium chloride, other metal chlorides, and significant quantities of plutonium, americium, and other metals. The direct oxide reduction salts consist primarily of a calcium chloride matrix and are contaminated with plutonium chloride, americium chloride, calcium oxide, calcium metal, plutonium oxide, plutonium fluoride, and other materials. A major difference in the possible processing of these residues is that the sodium chloride/potassium chloride matrix may be distilled from the contaminants, whereas the calcium chloride matrix is not readily distilled. The pyrochemical salt residues category also includes numerous materials that were associated with salt processing (e.g., crucibles) or that were generated during research activities. Because of technical considerations, a combination of the described processing technologies and sites may be required to process all of the pyrochemical salt residues.

The total quantity of pyrochemical salts at Rocky Flats subject to processing is approximately 14,900 kg (32,800 lb) and includes approximately 1,000 kg (2,200 lb) of plutonium. The technology/site options analyzed for processing salt residues are shown in **Figure 2–4**. The impacts associated with the management of salt residues are presented in Tables 2–12 through 2–15 and in Section 4.3.

The preferred processing technology for molten salt extraction/electrorefining salt residues and low plutonium concentration direct oxide reduction salt residues is repackaging and disposal at WIPP (Alternative 4). The plutonium concentration is low enough in these residues to be blended to 10 percent plutonium, using low plutonium concentration residues with the same characteristics or with other inert materials. This would allow the site to divert resources to other materials and to close the site at an earlier time than would be possible otherwise.

There are two preferred processing technologies for management of direct oxide reduction salt residues from Item Description Codes (IDCs) 365, 413, 417, and 427 and similar materials: (1) preprocessing at Rocky Flats followed by acid dissolution/plutonium oxide recovery at Los Alamos National Laboratory and (2) pyro-oxidation (if necessary) followed by repackaging (with blending to 10 percent plutonium, if necessary) at Rocky Flats for the remaining salt residues in these IDCs. (Although these four IDCs are sometimes called high plutonium concentration direct oxide reduction salt residues, they actually contain a mixture of high plutonium concentration and low plutonium concentration direct oxide reduction salt residues.)

DOE believes that there are only about 306 kg (675 lb) of high plutonium concentration direct oxide reduction salt residues from IDCs 365, 413, 417, and 427 that would need to be processed by the acid dissolution process at Los Alamos National Laboratory. However, a small quantity of additional material from other direct oxide reduction salt residue IDCs might be identified during physical inspection of the residues in an early part of the repackaging operation. Given this uncertainty, DOE analyzed the environmental impacts of processing up to 727 kg (1600 lb) of high plutonium concentration direct oxide reduction salt residues using the acid dissolution/plutonium oxide recovery process at Los Alamos National Laboratory. After processing, the plutonium oxide would be stored on an interim basis at Los Alamos National Laboratory in accordance with the Record of Decision issued after completion of the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1997e) until it would be disposed of in accordance with decisions to be made in the *Surplus Plutonium Disposition Environmental Impact Statement* (DOE 1997c). Plutonium contaminated magnesium oxide, a by-product of this process, would be dried and sent to WIPP for disposal as transuranic waste. The acid dissolution/plutonium oxide recovery

process at Los Alamos National Laboratory would result in much shorter exposures of the workers to radiation than would be experienced with the blend down process in Alternative 2 or repackaging in Alternative 4, thus providing health and safety benefits to the workers.

The preferred processing technology for direct oxide reduction salt residues from IDCs 365, 413, 417, and 427 that would not be processed at Los Alamos National Laboratory using acid dissolution/plutonium oxide recovery would be processing at Rocky Flats using pyro-oxidation/repackaging in preparation for shipment to WIPP for disposal as transuranic waste.

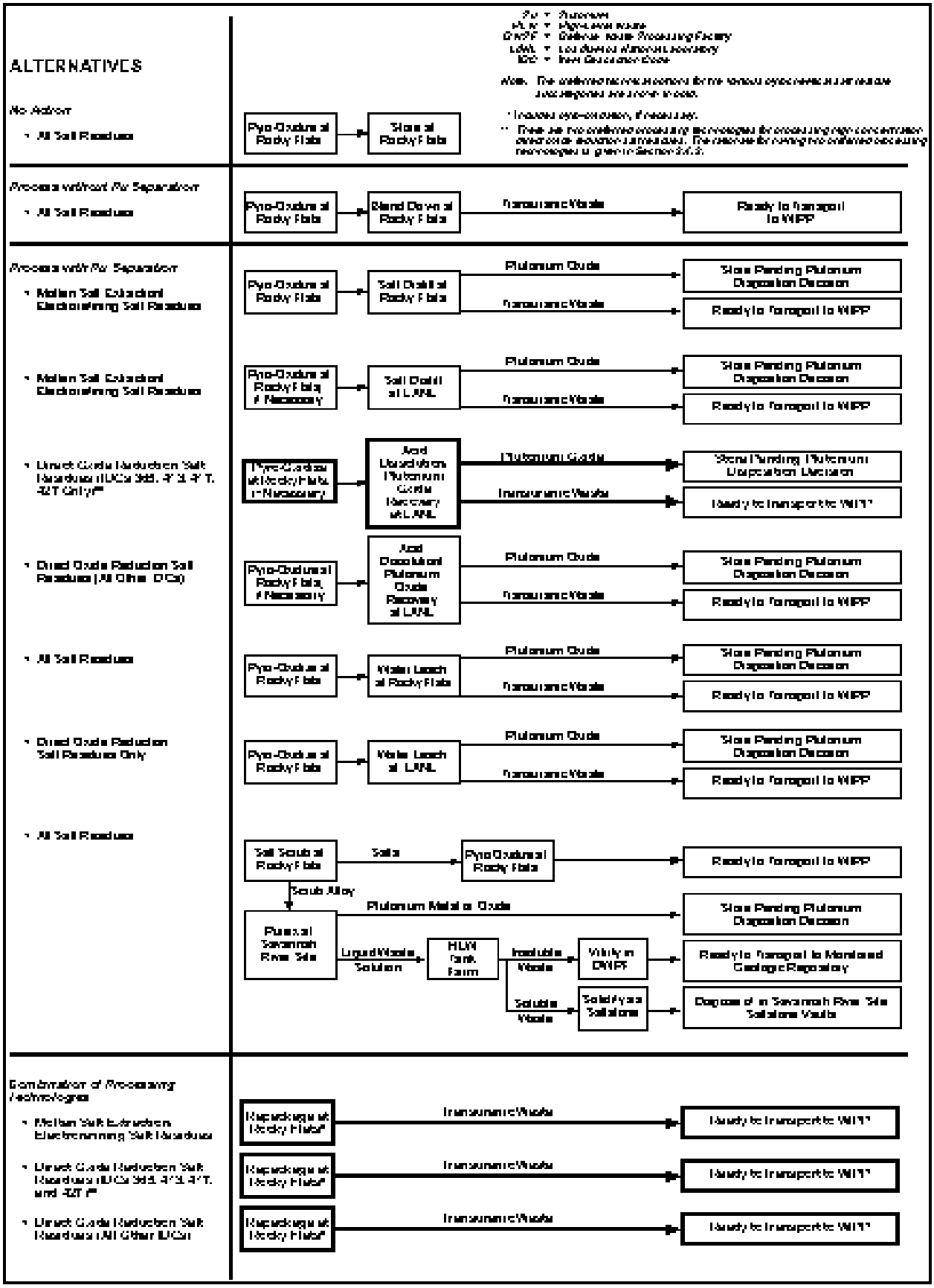

Figure 2–4 Processing Technologies for Pyrochemical Salt Residues

2.4.2.1 Alternative 1—No Action—Stabilize and Store

The methodologies for stabilizing plutonium residues to meet the Rocky Flats interim safe storage criteria are summarized below and are also analyzed in greater detail in the Solid Residue Environmental Assessment (DOE 1996k).

- **Pyro-Oxidation—**The salt residues under this alternative would be transferred to a glovebox in Module A of Building 707. An oxidant such as sodium carbonate would be added to the salt residue, and the mixture would be loaded into a stainless-steel can, which would be placed in a furnace, heated to about 800°C (1,470°F) in an inert atmosphere, and stirred for approximately two hours. As the molten salt cools, it would solidify into a solid monolith. After cooling, the pyro-oxidized salt would be packaged, removed from the glovebox, and placed in interim storage at Rocky Flats until DOE makes a final disposition decision. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has anlyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. Pyro-oxidation of salts in stationary furnaces is considered to be a proven technology.

  The repackaged, stabilized salt would be assayed to determine its plutonium content, placed in secondary packaging, and transferred to the designated onsite interim storage facility until a final disposition decision is made by DOE. The purpose of this oxidation is to ensure conversion of reactive metals to nonreactive oxides.

2.4.2.2 Alternative 2—Process without Plutonium Separation

DOE analyzed pyro-oxidation followed by blending down with inert materials to the safeguards termination limit as the technology that does not involve plutonium separation. A quantitative analysis of this technology was conducted for the Rocky Flats Site.

- **Pyro-Oxidation/Blend Down—**The salt residues would first be pyro-oxidized, if necessary, in a metal or ceramic crucible. After cooling, the salt matrix and plutonium oxide would be removed from the crucible. The crucible would be discarded and managed as transuranic waste or sand, slag, and crucible as described in Section 2.4.1. The salt and plutonium oxide would be crushed to achieve a uniform size and then blended with an inert material (such as pure salt or uranium oxide) to form a mixture that meets the plutonium safeguards termination limits. The salt would then be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.2.3 Alternative 3—Process with Plutonium Separation

DOE analyzed four processing technologies for separation of plutonium from the pyrochemical salt residues: (1) salt distillation (molten salt extraction/electrorefining salt residues only), (2) acid dissolution/plutonium oxide recovery (direct oxide reduction salts only), (3) water leach, and (4) salt scrub. Quantitative analyses were conducted for: salt distillation, water leach, and salt scrub of molten salt extraction/electrorefining salt residues at Rocky Flats; salt distillation of molten salt extraction/electrorefining salt residues at Los Alamos National Laboratory; water leach of direct oxide reduction salts at Rocky Flats; and acid dissolution/plutonium oxide recovery and water leach of direct oxide reduction salt residues at Los Alamos National Laboratory. Scrub alloy produced in the salt scrub process at Rocky Flats would be transported to the Savannah River Site for separation of plutonium using the Purex process as described in Section 2.4.10. Pyro-oxidation of the salts at Rocky Flats may be required before any shipment of salt residues to Los Alamos National Laboratory. Acid

dissolution/plutonium oxide recovery at Los Alamos National Laboratory was added as a process for direct oxide reduction salt residues between the Draft EIS and the Final EIS. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Salt Distillation—**This process would separate transuranic materials from a salt matrix by distilling the salt away from any plutonium/americium oxide present in the salt. For this EIS, DOE considered salt distillation only for molten salt extraction/electrorefining salt residues. Distillation of direct oxide reduction salt residues requires further development because higher temperatures are required for calcium chloride distillation and because it does not yield a good separation of the salt from plutonium/americium oxide (these higher temperatures are beyond the capability of available equipment). The salt would be pyro-oxidized, if necessary, and then loaded into the salt distillation furnace and heated under vacuum to approximately 950°C (1,740°F) for approximately six hours. Under these conditions, the salts would distill away from the plutonium/americium oxides in the mixture. No hazardous chemicals would be released during this process. After the separation, the furnace would be cooled and opened. The separated salts and plutonium/americium oxide/residual salts would then be assayed, packaged, and handled by two separate paths. The separated salts would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The plutonium/americium oxides would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in safe interim storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c).

  Pyro-oxidation of salts is considered to be a proven technology, although specific process variables are being evaluated in an attempt to make the pyro-oxidation process more compatible with a pyro-distillation follow-on processing step. Salt distillation of the sodium chloride/potassium chloride matrix from molten salt extraction/electrorefining salts has been well demonstrated on a pilot scale with actual residue materials, although optimization studies are ongoing and final designs of the production equipment will be required. An additional uncertainty involved in the salt distillation process is the disposition of the transuranic oxide materials resulting from distillation of salts from molten salt extraction salts. These materials contain elevated concentrations of americium compared to other plutonium oxide materials, resulting in elevated gamma radiation levels that may require extra shielding and special handling procedures.

- **Acid Dissolution/Plutonium Oxide Recovery at Los Alamos National Laboratory—**Recovery of plutonium from direct oxide reduction salt residues by acid dissolution at the Los Alamos National Laboratory would be conducted inside gloveboxes located in the Los Alamos Plutonium Facility (TA-55). The process would consist of dissolving the material in hydrochloric acid, followed by precipitation of the plutonium with oxalic acid, and then calcination to plutonium oxide.

  Acid dissolution would consist of first preparing a mixture containing equal amounts of salt residue and water and then adding concentrated hydrochloric acid to the mixture. Sodium chlorite next would be added to convert plutonium to the four valence state. This plutonium-bearing solution would be mixed with an organic solution consisting of tributylphosphate in dodecane. In the resulting solvent extraction process, plutonium would move into the organic phase while americium and calcium chloride salt, the matrix in direct oxide reduction salt residues, would remain in the aqueous phase. After the acid and organic solutions separate from one another, the aqueous phase would be sent to the raffinate tank for further processing. The organic phase would be stripped of plutonium using dilute hydrochloric acid and recycled. Hydroxylamine hydrochloride would then be added to the dilute acid solution containing plutonium to reduce plutonium to the three valence state.

Addition of oxalic acid to the plutonium-bearing solution would cause plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter and washed with dilute oxalic acid. Magnesium hydroxide would be added to the filtrate from oxalate precipitation and the raffinate from solvent extraction to precipitate any remaining plutonium and americium in those solutions. The magnesium hydroxide would then be filtered, calcined at 450°C (840°F), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The filtrate from the magnesium hydroxide precipitation process would be sent to TA-50, the Liquid Waste Treatment Facility. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 400°C (750°F) for one hour to decompose the plutonium oxalate to plutonium oxide and carbon dioxide and evaporate any entrained water. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. The plutonium oxide would then be thermally stabilized at 1,000°C (1,830°F) for four hours, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c). This process is a proven technology.

- **Water Leach—**The dissolution process being considered for recovery of plutonium/americium oxides from pyrochemical salts is water leach of the salt. In this process, the salt would first be pyro-oxidized, if necessary, as previously described in Section 2.4.2.1. The salt would then be placed in the leaching vessel and water would be added. Because the pyro-oxidation process produces an excess of sodium oxide, hydrochloric acid must be added to prevent the resulting solution from becoming excessively alkaline. After approximately one hour, the slurry would be vacuum filtered. The solid filter cake would consist primarily of damp plutonium/americium oxide, which would be placed in a furnace and dried at 400°C (750°F) for four hours. After drying, the plutonium/americium oxide would be calcined at 1,000°C (1,830°C) for four hours. No hazardous chemicals would be released during this process. The plutonium/americium oxide would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in interim storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c). The filtrate would be evaporated, leaving a lean salt that would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposition at WIPP.

  The water leach process is considered to be a proven technology. However, if it is used to process molten salt extraction salts, an uncertainty exists involving the disposal of the transuranic oxide materials remaining from the water leach of molten salt extraction salts. This is the same problem discussed above for salt distillation of these salts. The residual materials contain elevated concentrations of americium compared to other plutonium oxide materials, resulting in elevated gamma radiation levels that must be addressed in handling. Estimates of radiation levels from these oxides indicate that the materials require special handling procedures or shielding to be received at the new vault being constructed at the Savannah River Site.

- **Salt Scrub—**Salt scrub is the technology historically used to recover plutonium from molten salt extraction/electrorefining salt residues. This technology can also be used for direct oxide reduction salt residues. The salt residue would be placed in a crucible with a mixture of aluminum and magnesium (or, in newer processes, gallium and calcium) and heated in a glovebox furnace to approximately 800°C (1,470°F) for approximately two hours. Any plutonium and americium chlorides present in the residue would be reduced by magnesium (or calcium) to plutonium and americium metals, which would then be extracted by the aluminum (or gallium). The alloy would then separate from the salts and form a metallic button (called scrub alloy) at the bottom of the crucible.

After cooling, the salts and scrub alloy button would be removed from the crucible and separated from one another. The residual salts would be analyzed to determine if they meet safeguards termination limits for disposal at WIPP. Salts that meet the limits would be pyro-oxidized (as described previously in Section 2.4.2.1) to oxidize any reactive metals, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. Salts that do not meet the safeguards termination limits would be scrubbed again. The scrub alloy would be sent to the Savannah River Site to be processed in the Canyons using the Purex process (Section 2.4.10).

The salt scrub process is considered to be a proven process for clean, recently packaged salt residues. However, technical uncertainties exist for this process as applied to less pure salts and/or salts that have absorbed moisture during storage. Development work would be required prior to or in parallel with the operations to address these uncertainties, with the result possibly being a population of salts not amenable to this technique. Since the scrub alloy process could be performed in the stationary furnaces that have been installed at Rocky Flats as part of the No Action Alternative, a currently installed capability exists to support this process. The salts scrubbed by this process, however, may not meet the safeguards termination limits for disposal at WIPP and may need some subsequent processing prior to disposition.

2.4.2.4 Alternative 4—Combination of Processing Technologies

DOE analyzed repackaging at Rocky Flats as the only processing technology for pyrochemical salt residues under this alternative.

- **Repackaging—**DOE would apply a variance to the safeguards termination limits (or otherwise administratively terminate safeguards) for materials not requiring stabilization, although small quantities may be pyro-oxidized, if necessary. A variance would be based on a maximum plutonium concentration of 10 percent plutonium. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC. The materials would then be repackaged into containers and placed into pipe components, which would then be placed into drums. The drums would be placed in short-term storage pending disposition at WIPP as transuranic waste.

2.4.3 Management of Combustible Residues

The combustible plutonium residues are divided into three subcategories: aqueous-contaminated combustibles, organic-contaminated combustibles, and dry combustibles. These residues are solid materials contaminated with plutonium; they include gloves, clothes, and other combustible materials. Some of the combustible residues have been assigned hazardous waste codes under the Resource Conservation and Recovery Act. A description of the hazardous waste codes is provided in Table B–4 of Appendix B. After stabilization, these materials would no longer be ignitable, corrosive, or reactive. Such materials could be managed under Alternatives 1 or 4. Materials with the other hazardous waste codes meet the WIPP waste acceptance criteria (DOE 1996j). The total quantity of Rocky Flats combustible residues subject to processing is approximately 1,140 kg (2,510 lb) and includes approximately 21 kg (46 lb) of plutonium. The technology/site options analyzed for processing these residues are shown in **Figure 2–5**. The impacts of processing combustible residues are presented in Table 2–16 and Section 4.4.

DOE's preferred processing technology for all combustible residues is to stabilize and repackage the residues as described in Alternative 4 and send the residues to WIPP for disposal. Implementation of a variance to the safeguards termination limits for those residues would allow Rocky Flats to process the residues more rapidly and to close the site. The stabilization processes would be the same as those described for Alternative 1 (No

Action Alternative). For aqueous-contaminated combustible residues, the stabilization process would be neutralization followed by drying, with any fines stabilized by cementation or repackaging; for organic-contaminated combustible residues, it would be a combination of washing, low-temperature thermal desorption to remove volatile organic materials, stabilization of plutonium fines, mixing with an absorbent material, and cementation; and for dry combustible residues, it would be just to repackage the materials for disposal because they are already in a chemical or physical form that does not require stabilization. These are the technologies that are described in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k).

2.4.3.1 Alternative 1—No Action—Stabilize and Store

All processing activities for combustibles under the No Action Alternative would be conducted in existing glovebox lines in Building 371 at Rocky Flats. Specific stabilization methods for the aqueous-contaminated and organic-contaminated combustibles, as well as for dry combustibles, are described in the following paragraphs.

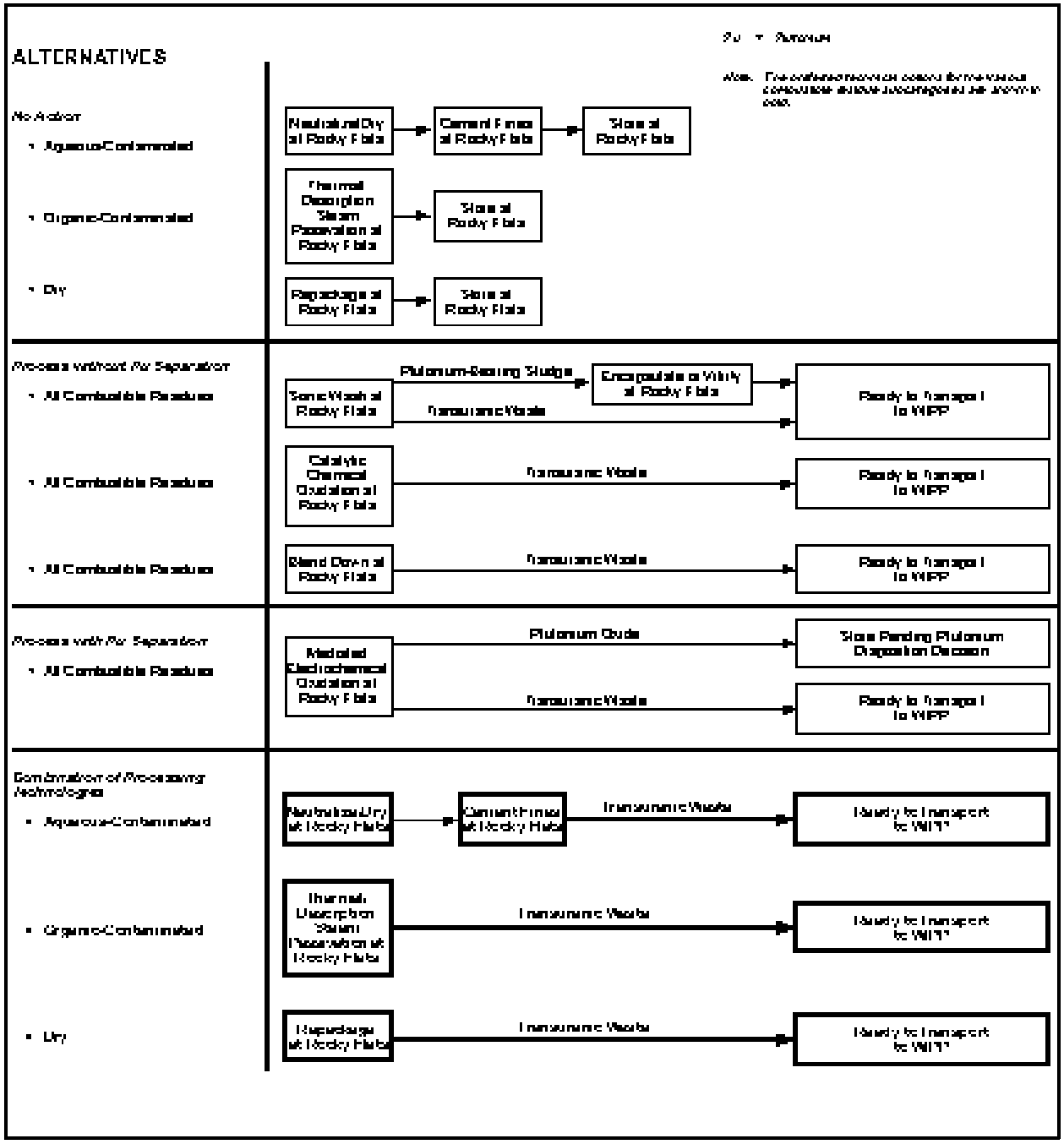

Figure 2–5 Processing Technologies for Combustible Residues

❒ **Neutralize/Dry**—Aqueous-contaminated combustibles are combustible materials that contain or have been exposed to discernible quantities of water-based solutions (typically acids or bases). Larger items would be size-reduced to facilitate washing. The materials would be washed with a neutralizing solution, excess liquid would be removed by filtration, and the remaining residues would be dried either by mixing with an absorbent material or by drying at low temperatures. Any fines resulting from this process would be immobilized by cementation or packaging. The remaining residue would be repackaged for interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to

remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. The washing solution would be periodically withdrawn, assayed for plutonium content, and sent to the liquid waste treatment facility. This process is currently in use at Rocky Flats.

- **Thermal Desorption/Steam Passivation—**The organic-contaminated combustibles would be stabilized by washing, low-temperature (approximately 80°C [176°F]) thermal desorption to remove volatile organic materials, stabilization of plutonium fines, mixing with an absorbent material, and cementation. Steam would be added to the low-temperature thermal desorption to stabilize plutonium fines. The stabilized residue would be repackaged for interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. This process is considered to be a proven technology; however, final process parameters are currently under investigation (for more details see Appendix C).

- **Repackage—**Dry combustible residues are in a chemical or physical form that does not require stabilization to meet interim safe storage criteria. The present packaging configuration, however, does not meet those criteria. Accordingly, these residues would be directly repackaged, without stabilization, into metal containers meeting interim safe storage criteria. After repackaging, the residue containers would be sent to an appropriate storage area until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. Repackaging is considered to be an acceptable alternative.

2.4.3.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three technologies that do not involve plutonium separation for processing combustible residues: sonic wash, catalytic chemical oxidation, and blend down with inert materials to the safeguards termination limits. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

- **Sonic Wash—**The sonic wash technology is applicable to all three subcategories of combustible residues. In this process, plutonium is physically removed from solid hydrogenous and other insoluble matrices by washing in a weak caustic solution with agitation induced by sound waves in the sonic range. The process mechanically improves contact of the neutralizing solution with the irregular matrix surfaces and improves the removal of solid transuranic oxides from the surface of the feed matrices. The feed material would be shredded, placed in a basket, and lowered into a sonic wash unit that contained a weak caustic solution. The charge would be agitated by sonic waves and a portion of the oxides, along with other higher density materials, would wash off the matrix and settle to the bottom. The matrix material would be rinsed, dried, and repackaged for shipment to WIPP for disposal. The settled heavy materials or sludges containing the higher fraction of transuranic oxides would be filtered from the wash solution, dried, and stored until a batch large enough to vitrify is gathered. The material first would be blended with a low-melting temperature glass, then heated to 700 to 1,300°C (1,290 to 2,370°F) to melt the glass and encapsulate or vitrify the waste. The stabilized material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The effluent streams from the filtration and rinsing steps would be evaporated and recycled back to the sonic wash unit.

The sonic wash technology has been demonstrated with residue-type materials on a bench scale. Because of the significant effort required to demonstrate a consistent process and develop the procedures and analysis necessary for routine operation, DOE estimates that this process would be available two years after the issuance of the Records of Decision for this EIS.

- **Catalytic Chemical Oxidation (Digestion)—**The process used to represent digestion of organic materials in combustible residues is the catalytic chemical oxidation process. This process uses catalysts dissolved in acid to oxidize organic materials and to dissolve metals associated with the residues at elevated temperatures and pressures. Any metals present, including plutonium, would be converted to metal oxides by boiling down the solution. The residual metal oxides would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

  Catalytic chemical destruction of combustibles at elevated temperatures and pressures has been demonstrated in a commercial environment, but is unproven as a production process in the size and service required and for residue material applications. Because of the significant effort required to demonstrate a consistent process and to develop the procedures and analysis necessary for routine operations, the estimated time to deploy this technology would be four years after the issuance of the Records of Decision for this EIS.

- **Blend Down—**Some materials that have plutonium concentrations only slightly above the safeguards termination limits may be shredded for efficient packing and blended with low-plutonium concentration materials (e.g., residues containing plutonium below the safeguards termination limits) or other appropriate materials. These materials would be introduced into a glovebox, shredded, diluted with other materials as required, and repackaged. The new packages would then be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.3.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation for all three kinds of combustible residues. A quantitative analysis of this technology was conducted for processing at Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Mediated Electrochemical Oxidation—**This process uses silver ions generated in an electrochemical cell to catalyze the dissolution of unreactive plutonium materials from residues and, depending on the substrate material, to convert some "combustible" materials into carbon dioxide and water. To ensure that a large surface area was exposed to the solution, the material would be shredded. Then the materials would be placed in a corrosion-resistant wire basket to allow solid-solution contact while maintaining the ability to remove the undissolved solids easily.

  In the mediated electrochemical oxidation dissolution process, a solution of silver nitrate in nitric acid would be pumped into an electrochemical cell, where the silver(I) ion would be oxidized to the silver(II) ion. The solution would be pumped immediately into the reaction tank, where it would dissolve plutonium oxide contained in the matrix, most organic and carbonaceous materials, and many other contaminants. Any solid material remaining after the reaction would be filtered, washed, dried, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

  Plutonium dissolved in the process would be mixed with a solution of oxalic acid, causing the plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter boat and washed with dilute nitric acid. The filtrate would be evaporated to recycle much of the water and acid, and

the evaporator bottoms would be neutralized, cemented, and packaged for shipment to WIPP for disposal. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 400°C (750°F) for four hours to decompose the oxalate and entrained water into the glovebox atmosphere, leaving a dry plutonium oxide cake. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. Later, the plutonium oxide would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). The remediated electrochemical oxidation process is considered to be a well demonstrated technology, although it has not yet been used in production operations in DOE facilities.

2.4.3.4 Alternative 4—Combination of Processing Technologies

DOE analyzed three processing technologies for combustible residues under Alternative 4. The analyses were based on application of a safeguards termination limit variance for a maximum 10 percent plutonium concentration to the stabilized residues. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material.

- **Neutralize/Dry—**This is the same stabilization technology described under the No Action Alternative in Section 2.4.3.1. DOE would apply a safeguards termination limit variance to these materials. After neutralization and drying, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Thermal Desorption/Steam Passivation—**This is the same stabilization technology described under the No Action Alternative in Section 2.4.3.1. DOE would apply a safeguards termination limit variance for these materials. After thermal desorption and steam passivation, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Repackage—**This is the same repackaging technology described under the No Action Alternative in Section 2.4.3.1. DOE would apply a safeguards termination limit variance to these materials. After repackaging, the stabilized residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.4 Management of Plutonium Fluoride Residues

The plutonium fluoride residues at Rocky Flats, which were generated in the hydrofluorination and reduction operations, are solid materials that have a high plutonium content. The alpha-neutron reaction, which occurs between alpha particles emitted from plutonium and fluorine, results in a high neutron emission rate from these residues and may cause a high neutron exposure to workers. The total quantity of Rocky Flats plutonium fluorides needing processing is approximately 315 kg (690 lb) and includes approximately 140 kg (310 lb) of plutonium. The technology/site options analyzed for plutonium fluoride residues are shown in **Figure 2–6**. The impacts associated with the management of plutonium fluorides are presented in Table 2–17 and Section 4.5.

DOE has identified the Purex process at the Savannah River Site (Alternative 3) as the preferred processing technology for processing plutonium fluoride residues because the Savannah River Site has existing operations (i.e., the F- and H-Canyons) that can process the material remotely, thus exposing the workers to less radiation

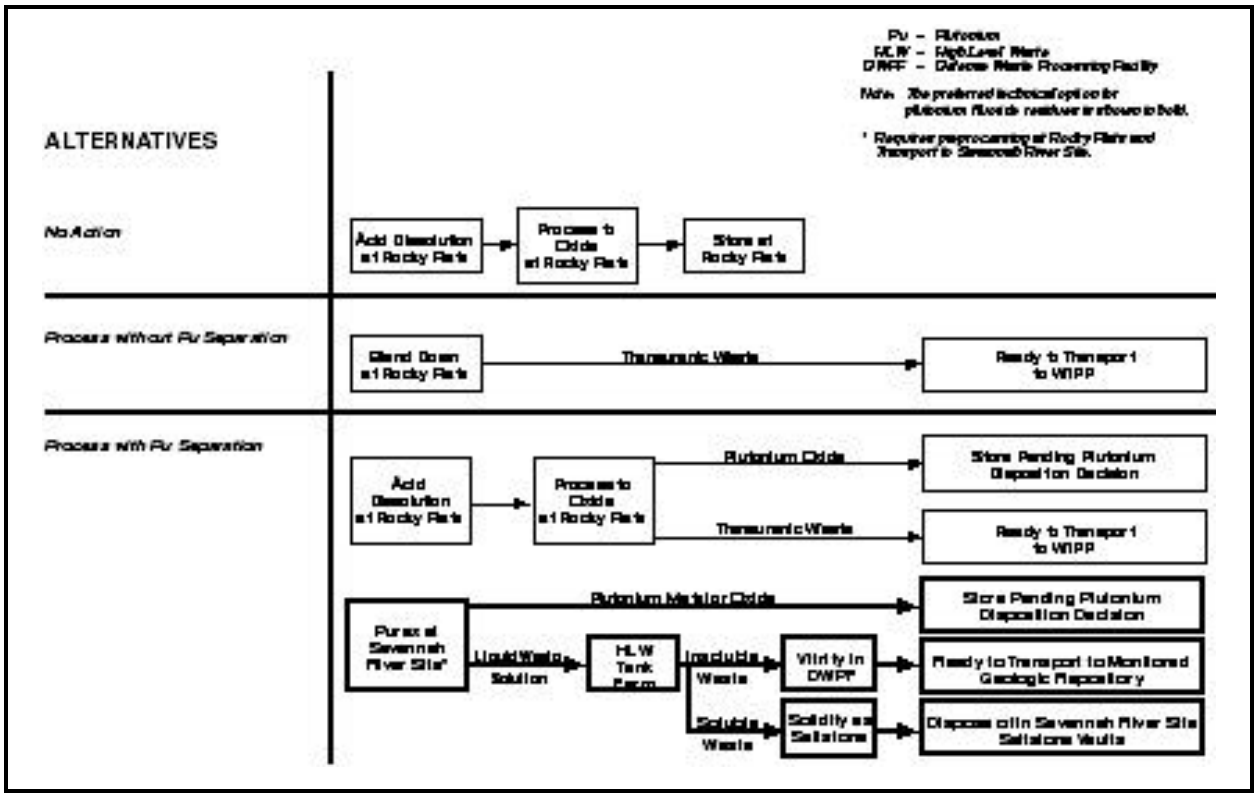

Figure 2–6 Processing Technologies for Plutonium Fluoride Residues

from alpha-n reactions than glovebox operations at Rocky Flats. Accordingly, significant health and safety benefits would accrue to workers by using the Purex process at the Savannah River Site.

2.4.4.1 Alternative 1—No Action—Stabilize and Store

- **Acid Dissolution/Plutonium Oxide Recovery—**Plutonium would be recovered from plutonium fluoride by dissolving the material in nitric acid. The resulting solution would be mixed with a solution of oxalic acid, causing the plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter boat and washed with dilute nitric acid. Magnesium hydroxide would be added to the precipitation filtrate to precipitate any remaining plutonium. This material would be filtered, calcined at 450°C (840°F), and repackaged for interim storage until final disposition. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 450°C (840°F) for four hours, decomposing the oxalate and evaporating entrained water into the glovebox atmosphere and leaving a dry plutonium oxide cake. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. The plutonium oxide would then be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage. This process is considered to be a proven technology.

2.4.4.2 Alternative 2—Process without Plutonium Separation

DOE analyzed blending the fluoride with inert materials to the safeguards termination limits as the processing technology without plutonium separation. A quantitative analysis of this technology was conducted for processing at Rocky Flats.

- **Blend Down—**The only technology applicable for this residue category is to blend the plutonium fluoride with an inert material such as uranium oxide, magnesium oxide, or salt. Although this material has a large concentration of plutonium (approaching 50 percent plutonium, by weight), the small quantity of this residue may make blending down reasonable. The processed material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.4.3 Alternative 3—Process with Plutonium Separation

DOE analyzed two technologies for separation of plutonium from plutonium fluoride residues: acid dissolution followed by plutonium oxide recovery and the Purex process. Quantitative analyses of these technologies were conducted for the acid dissolution process at Rocky Flats and for the Purex process at the Savannah River Site. Note that the No Action Alternative (Alternative 1) would also separate plutonium from plutonium fluoride; however, under the No Action Alternative the plutonium would remain in storage at Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Acid Dissolution/Plutonium Oxide Recovery—**This is the same technology that would be used in the No Action Alternative. The plutonium oxide recovered would be packaged according to DOE-STD-3013-96 (DOE 1996f) and stored pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c).

- **Purex Process—**This is the same technology previously described (in Section 2.4.1.3) for ash residues. The plutonium fluoride residues would be packaged for shipment to the Savannah River Site. At the Savannah River Site, the material would be dissolved in nitric acid in a Canyon facility and then recovered as metal or oxide in the Canyon finishing line.

2.4.4.4 Alternative 4—Combination of Processing Technologies

DOE is not evaluating the use of any technology option for the plutonium fluoride residue category under this alternative.

2.4.5 Management of Filter Media Residues

Two types of solid filter media residues exist at Rocky Flats—high-efficiency particulate air filters and Ful Flo filters. The high-efficiency particulate air filters are made of fiberglass and may be treated like other glasses; the Ful Flo filters are made from organic polymers. Some filter media residues at Rocky Flats have the Resource Conservation and Recovery Act hazardous waste designation for corrosivity. Upon treatment under the No Action Alternative (Alternative 1), the filters would be neutralized and would no longer be corrosive. Accordingly, the resultant transuranic wastes could be sent to WIPP for disposal. All other processes for filter media residues, except the blend down process, would also remove the corrosivity characteristic. The resulting transuranic wastes are acceptable for disposal at WIPP. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).]

The total quantity of filter media needing processing is approximately 2,630 kg (5,800 lb) and includes approximately 110 kg (240 lb) of plutonium. The processing technology/site options analyzed for filter media residues are shown in **Figure 2–7**. The impacts associated with the management of filter media residues are presented in Tables 2–18 through 2–20 and in Section 4.6.

DOE has identified blend down (Alternative 2) as the preferred alternative for Ful Flo filter media (IDC 331). This material was not identified in the Draft EIS as a material for which a variance to the safeguards termination limit had been requested, and accordingly, application of a variance was not considered for the Final EIS. The other viable processes for this residue are aqueous processes for which Rocky Flats has limited capacity. Neutralize/dry (Alternative 4) is the preferred processing technology for high-efficiency particulate air filter media (IDC 338). This material is contaminated with nitric acid and must be neutralized and dried prior to shipment to WIPP. DOE has determined that the remaining high-efficiency particulate air filter media residues are not wet and, therefore, do not need to be neutralized and dried. Accordingly, they would be repackaged under Alternative 4 and sent to WIPP for disposal. The average concentration of plutonium in the high-efficiency particulate air filter media residues is less than 10 percent, allowing them to be sent to WIPP for disposal with little processing. This would allow the site to reduce radiation risk to the public and workers, divert resources to processing other materials, and close the site at an earlier time than would be possible otherwise.

2.4.5.1 Alternative 1—No Action—Stabilize and Store

- **Neutralize/Dry—**These filter media would be neutralized and dried as described in Section 2.4.3.1. The product would be placed in interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

2.4.5.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three processing technologies for filter media residues that do not involve plutonium separation: vitrification (high-efficiency particulate air filter media only), blend down with inert materials to the safeguards termination limits, and sonic wash. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

- **Vitrification (High-Efficiency Particulate Air Filter Media Only)—**High-efficiency particulate air filter media are composed of fiberglass material; thus, they can be stabilized by mixing with glass frit and then heating until a vitrified melt is formed. The technology analyzed for high-efficiency particulate air filter media is the same as described in Section 2.4.1.2 for ash residues.

- **Blend Down—**Filter media may be shredded and blended with inert materials to meet the safeguards termination limits. Rocky Flats would use the same methodology previously described for combustible materials in Section 2.4.3.2.

- **Sonic Wash—**The sonic wash process uses sound waves to dislodge particles of plutonium oxide and other contaminants from the filter media. Then the media would be disposed of as transuranic waste, and the residual plutonium-bearing sludge would be stabilized by vitrification and also disposed of as transuranic waste. Rocky Flats would use the same process previously described for combustible materials in Section 2.4.3.2.

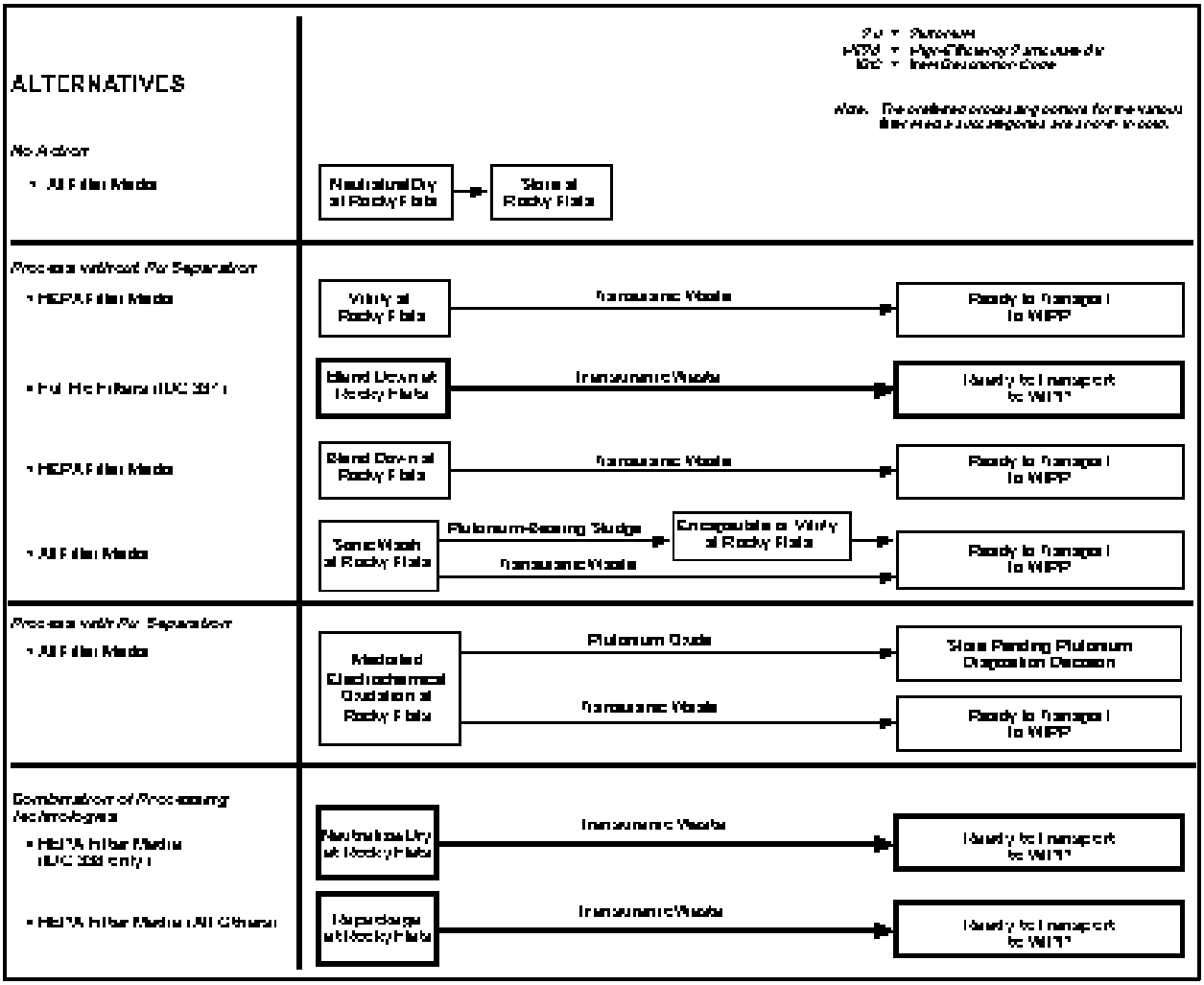

Figure 2–7 Processing Technologies for Filter Media Residues

2.4.5.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation for processing of filter media residues with plutonium separation. A quantitative analysis of the impacts of implementing this technology at Rocky Flats was conducted. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Mediated Electrochemical Oxidation—**This technology was described previously in Section 2.4.3.3. Plutonium dissolved in the process would be precipitated as an oxalate and then calcined to plutonium oxide. The oxide would then be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). Other solid material would be dried, stabilized, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.5.4 Alternative 4—Combination of Processing Technologies

DOE analyzed two processing technologies, neutralize/dry at Rocky Flats for high-efficiency particulate air filter media residues (IDC 338) and repackage for all other high-efficiency particulate air filter media residues. A description of these materials may be found in Section B.3.6 of Appendix B. In the No Action Alternative, all filter media were analyzed together and were assumed to be wet with nitric acid; however, DOE has determined that only materials in IDCs 331 and 338 contain nitric acid and require neutralization and drying for stabilization. The analyses were based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC, or with an inert material. Processing under this alternative was not considered for Ful Flo filter media (IDC 331).

- **Neutralize/Dry—**This is the same technology described under the No Action Alternative in Section 2.4.5.1. DOE would apply a variance to the safeguards termination limit for the high-efficiency particulate air filter media residues with IDC 338. After neutralization and drying, the stabilized residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Repackaging—**This technology would apply to all high-efficiency particulate air filter media residues except for those with IDC 338. The material would be repackaged to meet the WIPP waste acceptance criteria and the 10 percent plutonium variance to the safeguards termination limit; then it would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.6 Management of Sludge Residues

Sludges were generated by a variety of processes at Rocky Flats. Some of the sludge residues at Rocky Flats have Resource Conservation and Recovery Act hazardous waste designations. (See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).) Sludges with corrosivity hazardous waste designations would be neutralized prior to shipment to WIPP to remove the corrosivity characteristic. The total quantity of sludges needing processing is approximately 620 kg (1,370 lb), including approximately 27 kg (60 lb) of plutonium. The technology/site options analyzed for sludge residues are shown in **Figure 2–8**. The impacts associated with the management of sludge residues are presented in Tables 2–21 and 2–22 and Section 4.7.

DOE has identified the repackage process (Alternative 4) as the preferred processing technology for the sludge residues with IDCs 089, 099, and 332, because these greases and oily sludges are not easily processed by other means and because of the small quantity (7.0 kg [15.4 lb] bulk, 0.95 plutonium) that would be repackaged. (A description of the materials in each item description code is presented in Appendix B.) The preferred alternative for all other sludge residues is filtration followed by drying (Alternative 4) because implementation of the variance would allow Rocky Flats to process the material most expeditiously and close the site.

2.4.6.1 Alternative 1—No Action—Stabilize and Store

- **Filter/Dry—**The stabilization process assumed in the No Action Alternative is to process miscellaneous sludges by filtering off any excess liquid and drying the remaining material by mixing with an absorbent. The resulting dried material would be tested to determine if respirable fines are present. Any fines present would be immobilized using a process such as cementation. The final step would be to repackage the residue for interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be

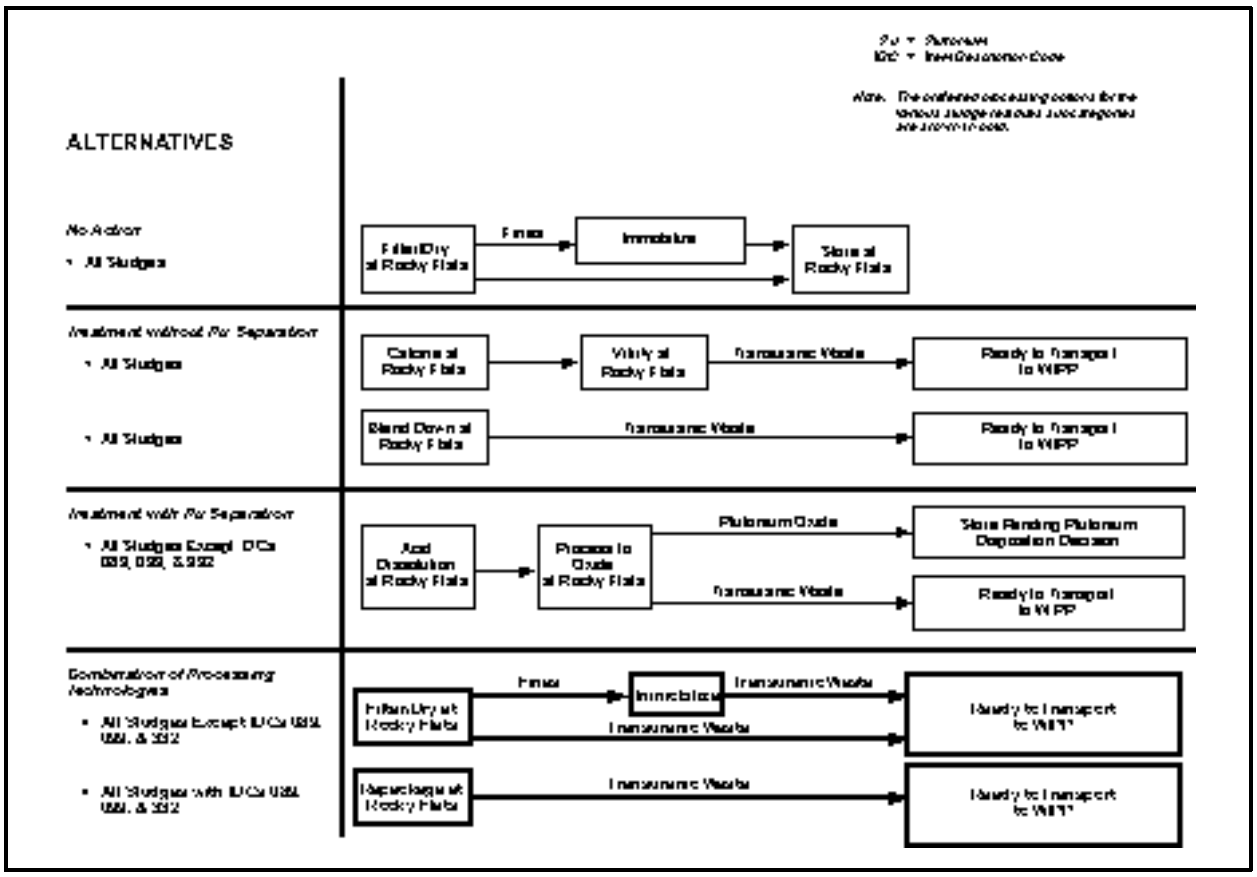

Figure 2–8 Processing Technologies for Sludge Residues

identified, DOE has analyzed the annual impacts of such storage in this EIS. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with the perspective on the effects of a prolonged storage period. The small quantity of liquid would be sent to the Rocky Flats liquid waste treatment facility. This process is considered to be a proven technology.

2.4.6.2 Alternative 2—Process without Plutonium Separation

DOE analyzed two technologies for processing sludge residues, including greases and oily sludge residues, that do not involve plutonium separation: vitrification and blend down with inert materials to the safeguards termination limits. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

- **Vitrification—**Vitrification of sludges at Rocky Flats would be done in a furnace placed inside a glovebox. The procedure used would be the same as the procedure for ash residues described in Section 2.4.1.2.

- **Blend Down—**Sludge residues would be blended with an inert material, such as uranium oxide or magnesium oxide, to form a mixture that meets plutonium safeguards termination limits. The residues would be analyzed for plutonium content; moved to Module B, Building 707; and bagged into the glovebox. The residues would then be unpacked, size-reduced as necessary, diluted by mixing with an inert material (including an absorbent to dry any free liquids), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.6.3 Alternative 3—Process with Plutonium Separation

DOE analyzed one technology for processing sludge residues that involves plutonium separation: acid dissolution followed by plutonium oxide recovery. A quantitative analysis of the impacts of implementing this technology was conducted for Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Acid Dissolution/Plutonium Oxide Recovery—**Recovery of plutonium from sludges (except greases and oily sludges) by acid dissolution would consist of dissolving the material in nitric acid followed by precipitation of the plutonium with oxalic acid. The feed material would be size-reduced to a powder or granular material, which would be introduced into the dissolver using a screw feeder. The dissolver would be charged with 7.5 molar nitric acid, which would recirculate within the dissolver column. The dissolver would be sparged (agitated) with air to prevent settling of solids and to provide intimate contact between solids and acids.

  The plutonium dissolved in the process would be mixed with a solution of oxalic acid, causing the plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter boat and washed with dilute nitric acid. Magnesium hydroxide would be added to the precipitation filtrate to precipitate any remaining plutonium. This material would then be filtered, calcined at 450 °C (840°F), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 450°C (840°F) for four hours, thereby decomposing the oxalate, evaporating entrained water into the glovebox atmosphere, and leaving a dry plutonium oxide cake. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. The plutonium oxide would then be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f) requirements, and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). This process is considered to be a proven technology.

2.4.6.4 Alternative 4—Combination of Processing Technologies

DOE analyzed two processing technologies: repackage at Rocky Flats for sludge residues having IDCs 089, 099, and 332 and filter/dry at Rocky Flats for all other sludge residues. A description of these materials may be found in Section B.3.5 of Appendix B. In the No Action Alternative, all sludge residues were analyzed together and were assumed to be wet; however, DOE has determined that the material in the three IDCs are not wet. Therefore, they only require repackaging for stabilization. The analyses were based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material.

- **Filter/Dry—**This is the same technology described under the No Action Alternative in Section 2.4.6.1. DOE would apply a variance to the safeguards termination limit for the sludge residues (except IDCs 089, 099, and 332). After filtration and drying, the stabilized residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Repackaging—**This technology would apply to all sludge residues with IDCs 089, 099, and 332. The material would be repacked to meet the WIPP waste acceptance criteria and the 10 percent plutonium variance to the safeguards termination limit, then placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.7 Management of Glass Residues

This category is composed of Raschig rings and other miscellaneous glass residues. Raschig rings are hollow borosilicate glass cylinders that are 3.8 cm (1.5 in) long by 3.8 cm (1.5 in) diameter and 0.48 cm (0.19 in) thick. They are used to absorb neutrons and thus prevent criticality in large process tanks. Over time, the rings become coated with insoluble plutonium compounds. Some of the glass residues at Rocky Flats have Resource Conservation and Recovery Act hazardous waste designations that are acceptable at WIPP in materials to be disposed of as transuranic waste. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).] The total quantity of glass residues at Rocky Flats needing processing is approximately 135 kg (300 lb) and includes approximately 5 kg (11 lb) of plutonium. The technology/site options analyzed for processing these materials are shown in **Figure 2–9**. The impacts associated with the management of glass residues are presented in Table 2–23 and Section 4.8.

DOE's preferred processing technology for glass residues is stabilization by neutralization and drying (Alternative 4) because implementation of a variance would allow Rocky Flats to process the material most expeditiously and close the site. Large items would be size-reduced to facilitate washing, and any fines would be stabilized by cementation or repackaging. This is the technology described for glass residues in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k).

2.4.7.1 Alternative 1—No Action—Stabilize and Store

- **Neutralize/Dry—**The process assumed for stabilizing glass residues in the No Action Alternative is the same as the Neutralize/Dry process described in Section 2.4.3.1 for aqueous-contaminated combustible residues. Larger items would be size-reduced to facilitate washing. The materials would be washed with a neutralizing solution; excess liquid would be filtered off; and the remaining residues would be dried either by mixing with an absorbent material or by heating at low temperatures and then repackaged for interim storage pending disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. The washing solution would be periodically withdrawn, assayed for plutonium content, and sent to the liquid waste treatment facility in Building 374.

2.4.7.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three technologies for processing glass residues that do not involve plutonium separation: vitrification, blend down with inert materials to the safeguards termination limits, and sonic wash. Quantitative analyses of implementing these technologies at Rocky Flats were conducted.

- **Vitrification—**Because these residues are composed of various forms of glass, they are readily vitrified. The technology that would be used at Rocky Flats is vitrification in a furnace, as described for ash residues in Section 2.4.1.2.

- **Blend Down—**The residues would be moved to Module B, Building 707, at Rocky Flats and bagged into the glovebox. Then the residues would be unpacked, size-reduced as necessary, diluted by mixing with inert materials (including an absorbent to dry any free liquids), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

❒ **Sonic Wash—**The sonic wash process for glass residues is the same as the process described for combustibles in Section 2.4.3.2.

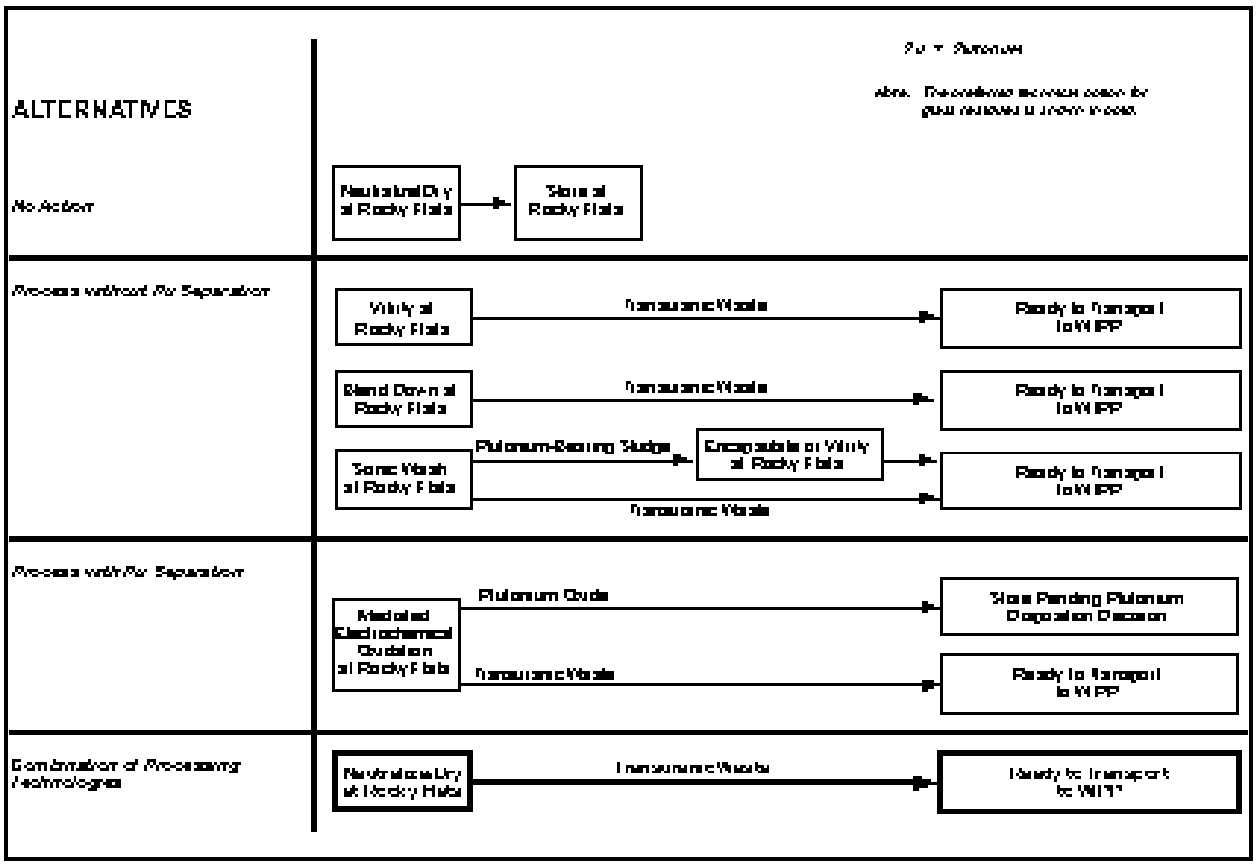

Figure 2–9 Processing Technologies for Glass Residues

2.4.7.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation for processing of glass residues with plutonium separation at Rocky Flats. A quantitative analysis of the impacts of implementing this technology was conducted for Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

❒ **Mediated Electrochemical Oxidation—**This technology was described previously in Section 2.4.3.3. Plutonium dissolved in the process would be precipitated as an oxalate and then calcined to plutonium oxide. The oxides would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). Any other solid residues would be dried, stabilized, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.7.4 Alternative 4—Combination of Processing Technologies

DOE analyzed neutralize/dry at Rocky Flats as the only processing technology for glass residues under this alternative. The analysis was based on application of a variance to the safeguards termination limit for a

maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material.

- **Neutralize/Dry—**This is the same stabilization technology described under the No Action Alternative in Section 2.4.7.1. DOE would apply a variance to the safeguards termination limit for these materials. Accordingly, after neutralization and drying, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.8 Management of Graphite Residues

The graphite residues generated during foundry operations at Rocky Flats are solid pieces of graphite from broken and intact molds. Some of the graphite residues at Rocky Flats have Resource Conservation and Recovery Act hazardous waste designations that are acceptable at WIPP in materials to be disposed of as transuranic waste. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).] The total quantity of graphite needing processing is approximately 1,880 kg (4,140 lb), including approximately 97 kg (215 lb) of plutonium. The technology/site options analyzed for processing graphite residues are shown in **Figure 2–10**. The impacts associated with the management of graphite residues are presented in Table 2–24 and Section 4.9.

DOE's preferred processing technology for graphite residues is to repackage (Alternative 4) because implementation of a variance to the safeguards termination limit would allow Rocky Flats to process the material most expeditiously and close the site. This is the processing described for graphite residues in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k).

2.4.8.1 Alternative 1—No Action—Stabilize and Store

- **Repackage—**Graphite residues would be directly repackaged into metal containers meeting interim safe storage criteria. After repackaging, the residue containers would be sent to an appropriate storage area for interim storage pending disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

2.4.8.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three technologies for processing graphite residues that do not involve plutonium separation: cementation, vitrification, and blend down with inert materials to the safeguards termination limits. Quantitative analyses of implementing these technologies at Rocky Flats were conducted.

- **Immobilization (Cementation)—**The graphite residues would be size-reduced, cemented, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The process is considered to be a proven technology.

- **Immobilization (Vitrification)—**In the Rocky Flats furnace vitrification process, the graphite residues would be placed in Module E, Building 707. The residues would be unpacked, sorted, size-reduced (as necessary), and measured into 2-l (0.5-gal) cans. The amount of material added to the cans would be limited to 83.5 g (0.18 lb) plutonium per can. The residues would be calcined before vitrification to prevent

off-gases from combusting during vitrification. Glass frit would be added until the resulting material would be below the safeguards termination limits for vitrified material. The mixture would then be melted to form a glass. After cooling, the cans of vitrified material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. This process is considered to be proven technology. Activities are underway to optimize the process and reduce the steps necessary to achieve an acceptable waste form.

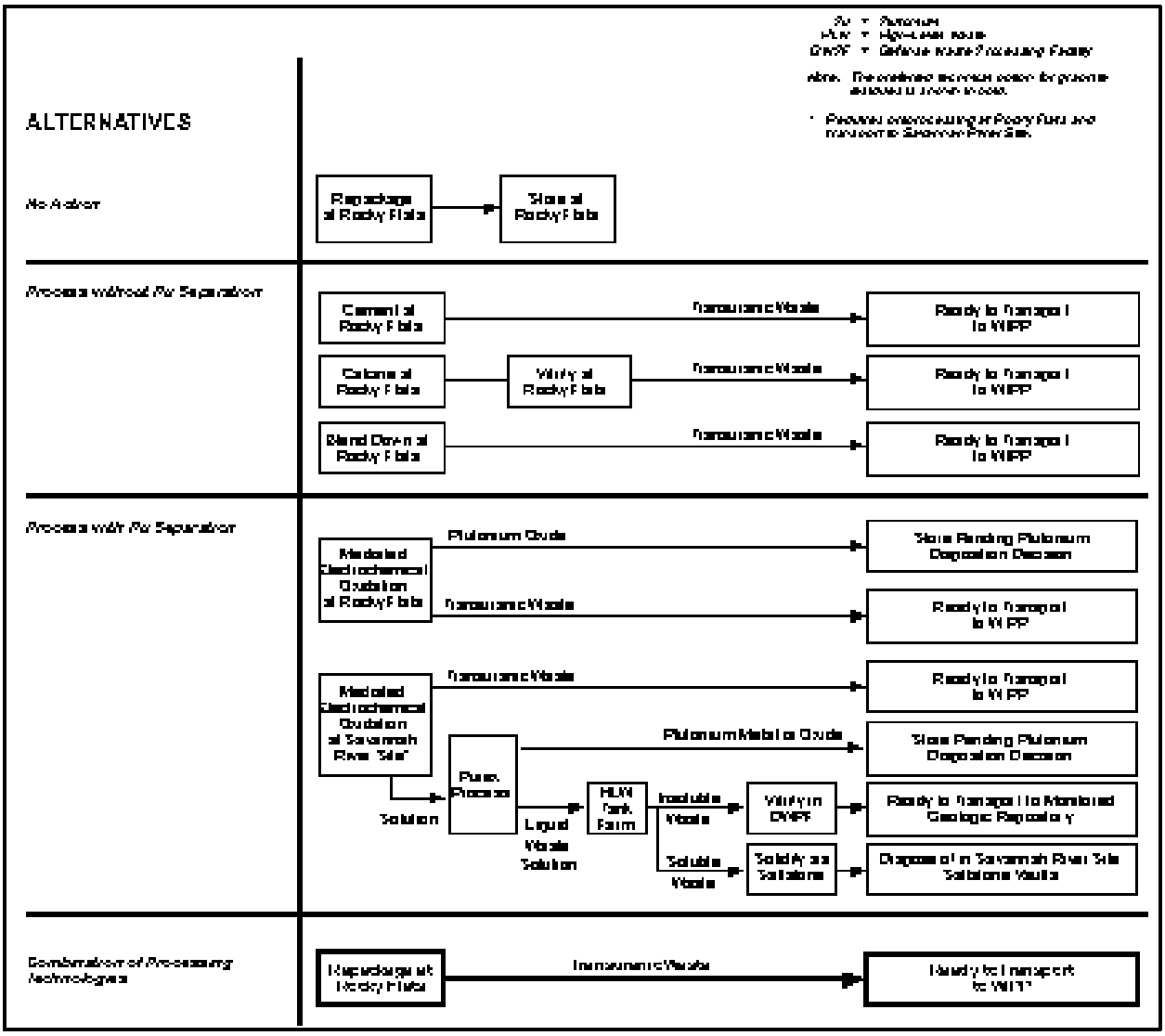

Figure 2–10 Processing Technologies for Graphite Residues

❒ **Blend Down**—The plutonium concentration in graphite residues would be decreased by blending with an inert material for disposal at WIPP without further processing. The residues first would be moved to Module B, Building 707, and bagged into the glovebox. The residues would be unpacked, size-reduced as necessary, diluted by mixing with an inert material, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.8.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation as the only technology for processing graphite residues with plutonium separation. Quantitative analysis of the impacts of implementing this technology were conducted for Rocky Flats and the Savannah River Site. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Mediated Electrochemical Oxidation—**At both Rocky Flats and the Savannah River Site, plutonium would be dissolved using the silver(II) ion to oxidize the plutonium. Any remaining insoluble material would be removed by filtration, dried and packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The plutonium-bearing solution, however, would be treated differently at the two sites. At Rocky Flats, the plutonium would be precipitated as plutonium oxalate, then calcined to plutonium oxide. At the Savannah River Site, the plutonium-bearing solution would be further treated using the Purex process to produce plutonium metal or oxide. These processes were previously described in Section 2.4.3.3 and Section 2.4.1.3 for Rocky Flats and the Savannah River Site, respectively. In both cases, the plutonium metal or plutonium oxide would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c).

2.4.8.4 Alternative 4—Combination of Processing Technologies

DOE analyzed repackaging at Rocky Flats as the only processing technology for graphite residues under this alternative. The analysis was based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC, or with an inert material.

- **Repackaging—**This is the same technology described under the No Action Alternative in Section 2.4.8.1. DOE would apply a variance to the safeguard termination limit for these materials. Accordingly, after repackaging, the residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.9 Management of Inorganic (Metal and Others) Residues

Inorganic residues are solids (e.g., metals, ceramics, and oxides) used during production operations that do not have any combustible components. Some of the inorganic residues at Rocky Flats have a Resource Conservation and Recovery Act hazardous waste designation that is acceptable at WIPP in materials to be disposed of as transuranic waste. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).] The total quantity of inorganic residues needing processing is approximately 460 kg (1,000 lb) and includes approximately 18 kg (40 lb) of plutonium. The technology/site options analyzed for processing inorganic residues are shown in **Figure 2–11**. The impacts associated with the management of inorganic residues are given in Table 2–25 and Section 4.10.

DOE's preferred processing option for inorganic (metal and other) residues is repackaging without further processing and the application of a variance to the safeguards termination limit for the stabilized residues (Alternative 4) because implementation of variances would allow Rocky Flats to process the materials most expeditiously and close the site. This is the process described for inorganic residues in the Rocky Flats Solid Residue Environment Assessment (DOE 1996k).

2.4.9.1 Alternative 1—No Action—Stabilize and Store

- **Repackage—**These residues would be repackaged into metal containers meeting interim safe storage criteria. After repackaging, the residue containers would be sent to an appropriate storage area for interim storage pending disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the

annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

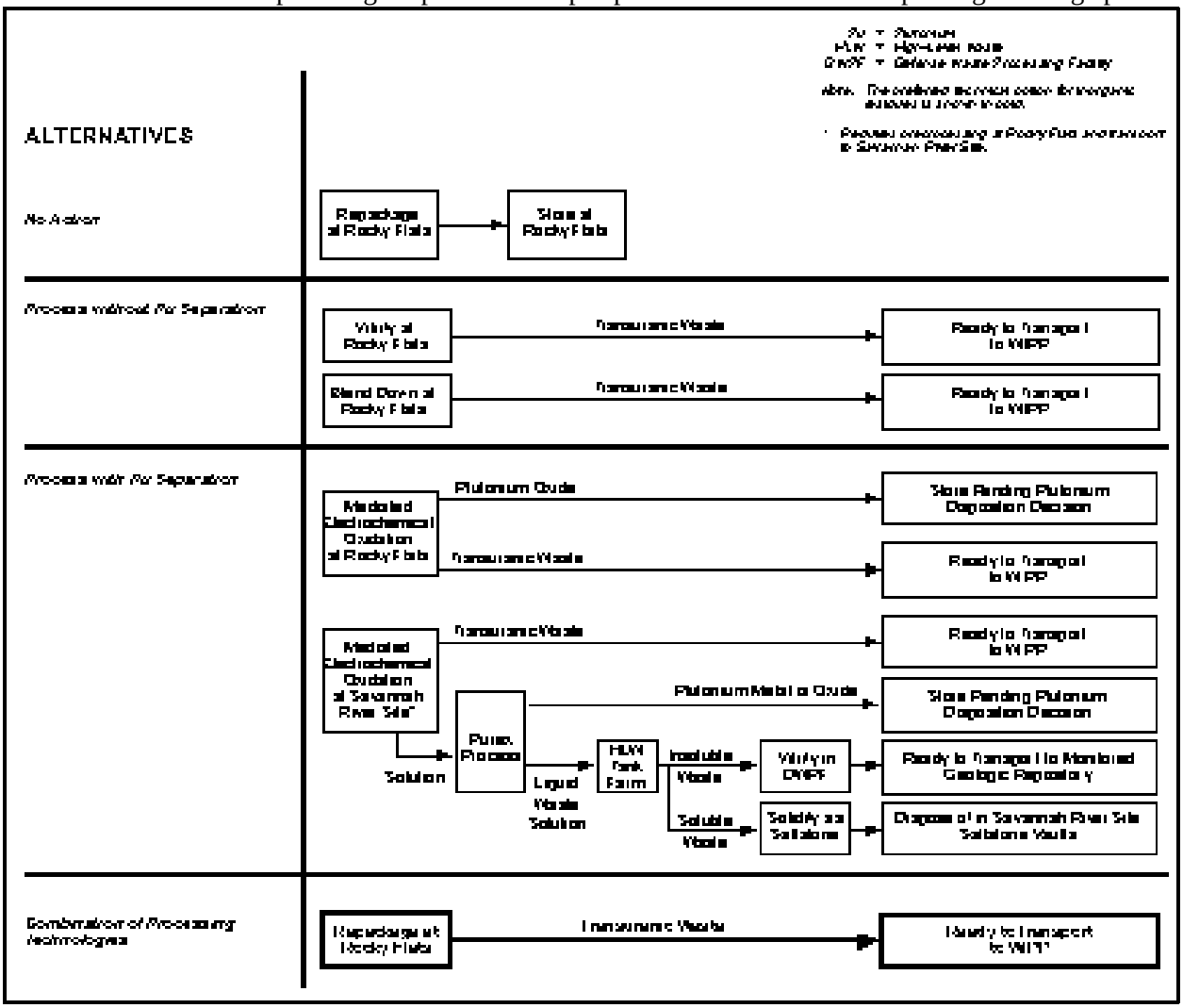

Figure 2–11 Processing Technologies for Inorganic Residues

2.4.9.2 Alternative 2—Process without Plutonium Separation

DOE analyzed two technologies that do not involve plutonium separation for processing inorganic residues: vitrification and blend down with inert materials to the safeguards termination limits. Quantitative analyses of these technologies at Rocky Flats were conducted.

- **Immobilization (Vitrification)—**In the vitrification process, the residues would be placed in Module E, Building 707, unpacked, sorted, size-reduced (as necessary), and weighed into 8.2-L (2.2-gal) cans. The amount of material added to the cans would be limited to 83.5 g (0.18 lb) of plutonium per can, the maximum permissible for shipment to WIPP. Glass frit would be added to the cans until the resulting material reaches the safeguards termination limit for vitrified material. The mixture then would be melted and encapsulated in glass. After cooling, the vitrified ash would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The process is considered to

be a proven technology. Activities are underway to optimize the process and reduce the steps necessary to achieve an acceptable waste form.

- **Blend Down—**The plutonium concentration of the residues would be decreased by blending with an inert material for disposal at WIPP without further processing. The residues would be moved to Module B, Building 707, and bagged into the glovebox. Then the residues would be unpacked, size-reduced as necessary, diluted by mixing with an inert material (including an absorbent to dry any free liquids), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.9.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation as the only technology for processing inorganic residues with plutonium separation. Quantitative analyses of the impacts of implementing this technology at Rocky Flats and the Savannah River Site were conducted. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Mediated Electrochemical Oxidation—**This process was described previously in Section 2.4.3.3 and Section 2.4.1.3 for Rocky Flats and the Savannah River Site, respectively.

2.4.9.4 Alternative 4—Combination of Processing Technologies

DOE analyzed repackaging at Rocky Flats as the only processing technology for inorganic (metal and other) residues under this alternative. The analysis was based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC, or with an inert material.

- **Repackaging—**This is the same technology described under the No Action Alternative in Section 2.4.9.1. DOE would apply a variance to the safeguards termination limit for these materials. After repackaging, the residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.10 Management of Scrub Alloy

Scrub alloy is a solid metal mixture of magnesium, aluminum, americium, and plutonium that was generated during the salt scrub processing of molten salt extraction salts and the anode alloy processing of electrorefining anode heels. Some of the scrub alloy is from developmental programs and contains calcium/gallium or calcium/cerium. The total quantity of scrub alloy at Rocky Flats needing processing is approximately 700 kg (1,540 lb), including approximately 200 kg (440 lb) of plutonium. The processing technology/site options analyzed for scrub alloy are shown in **Figure 2–12**. The impacts associated with the management of scrub alloy are presented in Table 2–26 and Section 4.11.

DOE has identified the Purex process at the Savannah River Site as the preferred processing technology for scrub alloy because this would allow the material to be processed remotely, resulting in lower radiation exposure to the workers and thus providing health and safety benefits. The Purex process is the traditional methodology for processing scrub alloy from Rocky Flats.

2.4.10.1 Alternative 1—No Action—Stabilize and Store

❒ **Continued Storage (Repackage as Necessary)**—In the No Action Alternative, scrub alloy would continue to be stored in vaults at Rocky Flats until a suitable disposition was determined. The material would be monitored for leaks and deterioration of the packaging. As repackaging becomes necessary, the drums would be unpacked, and the packages would be entered into a glovebox where the scrub alloy buttons would be placed in new cans. The cans would be removed from the glovebox and placed in new drums for safe,

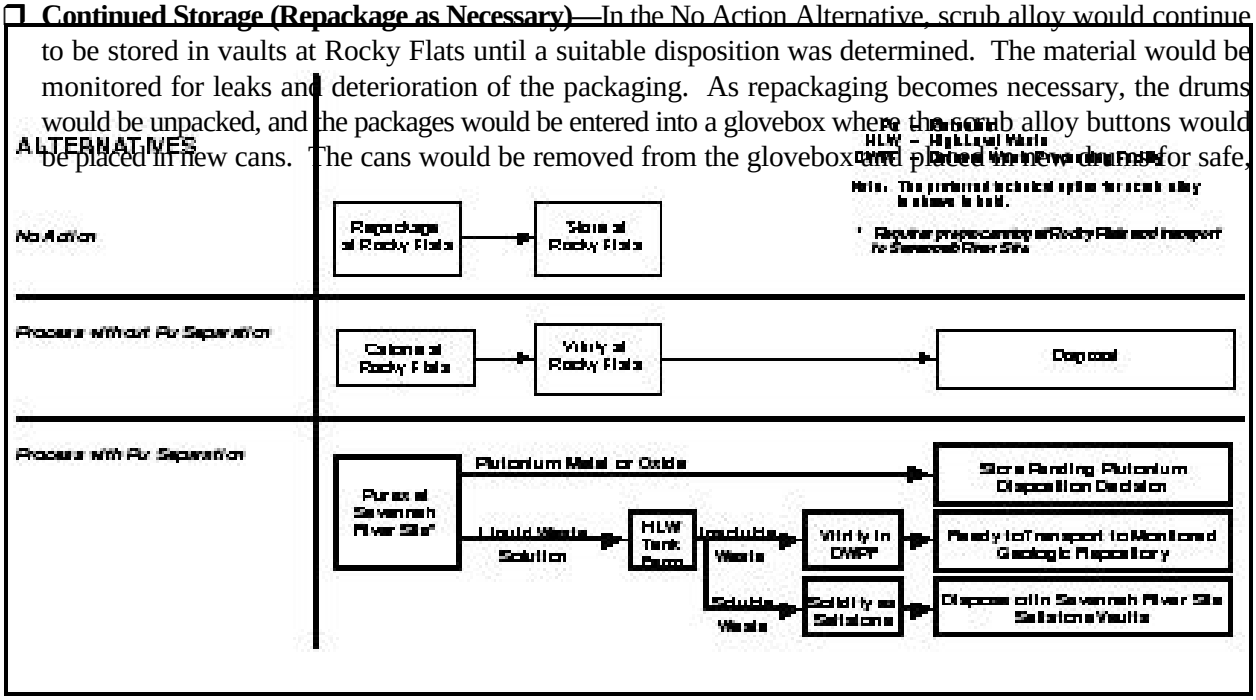

Figure 2–12 Processing Technologies for Scrub Alloy

secure storage until a final disposition decision was made by DOE. As there is no basis for estimating how long the scrub alloy might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

2.4.10.2 Alternative 2—Process without Plutonium Separation

DOE analyzed calcination of scrub alloy followed by vitrification for processing of scrub alloy without plutonium separation. Quantitative analysis of the impacts of implementing this technology was conducted at Rocky Flats.

❒ **Calcination/Vitrification**—The vitrification process proposed by Rocky Flats for scrub alloy requires two steps. First, the scrub alloy would be converted to an oxide by burning and calcining at 600°C (1,110°F) and 1,000°C (1,830°F), respectively. Next, the calcined material would be blended with sufficient glass frit to make a product that would satisfy the safeguards termination limits, then heated in a furnace to a temperature of 700 to 1,300°C (1,290 to 2,370°F). The end product would consist of a vitrified monolith containing less than 5 percent plutonium. After processing, material would be packaged and placed in interim storage pending disposal or other disposition.

Because calcination of powdered or granular materials in muffle furnaces is considered to be a proven technology and plutonium metals and other alloys have been routinely burned in the past, calcination of scrub alloy is considered to be a low-risk technology, although it has not been specifically proven in this context. The vitrification process of fusing the metal oxide with glass frit in a muffle furnace to form a

nonuniform, amorphous, encapsulated product should be identical to the vitrification process described for other materials in this EIS.

This disposition of scrub alloy through a calcination and vitrification process was not envisioned as a disposal approach during the development of the WIPP Supplemental EIS-II (DOE 1997a) and, therefore, scrub alloy was not included in the WIPP Baseline Inventory Report. Further NEPA review would be needed for disposal of the transuranic waste generated from this particular processing of the scrub alloy. In the event that this technology was implemented, the resulting material (although of satisfactory composition and form) might be subject to disposal delays because of the necessity to revise regulatory documentation. Because this material has historically been considered to be "War Reserve" material, its final disposition to WIPP has not been programmatically evaluated. This calcination/vitrification, although technically viable, is not a desirable processing technology for scrub alloy at Rocky Flats because of the large quantity of transuranic waste that would be generated and because disposal of material generated by this process was not analyzed in the WIPP Supplemental EIS-II (DOE 1997a). An estimate of the impacts of transporting the transuranic wastes generated from the calcination/vitrification process to WIPP is presented in Appendix E, Section E.6.5 of this EIS.

2.4.10.3 Alternative 3—Process with Plutonium Separation

DOE analyzed the Purex process for processing scrub alloy with plutonium separation. A quantitative analysis of the impacts of implementing this technology at the Savannah River Site was conducted. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Purex Process**—Scrub alloy would be packaged for shipment at Rocky Flats and shipped to the Savannah River Site. At the Savannah River Site, the scrub alloy would be received at the 235-F Storage Facility and transferred to a canyon facility, where it would be dissolved in nitric acid. The solution would be processed through a finishing line as with other stabilization processes. The product would be plutonium metal or oxide that would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage in the FB-Line vaults (or in the Actinide Packaging and Storage Facility when completed), pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). The Purex process is considered to be a proven technology at the Savannah River Site.

2.4.10.4 Alternative 4—Combination of Processing Technologies

DOE has not analyzed any technology under this alternative for scrub alloy.

2.5 STRATEGIC MANAGEMENT APPROACHES

In addition to evaluating the alternatives for management of the plutonium residues and scrub alloy for each individual material category, as discussed in Section 2.4, DOE has also evaluated several "Strategic Management Approaches." These approaches involve the compilation of a complete set of processing options which allows a specific management criterion to be met. Constructing these Strategic Management Approaches allows presentation of the environmental impacts of the proposed action as one set of numbers, instead of several different sets of numbers representing the impacts from management of each of the different material categories individually.

In constructing these Strategic Management Approaches, DOE is not necessarily suggesting that any of them, other than the Preferred Alternative, would be implemented. Rather, DOE recognizes that there is a very large

number of combinations of material category, processing technology, and management site that could be constructed— too many to individually analyze and present in an understandable manner in this EIS. Rather than trying to present all of the combinations that could be generated, DOE has developed a subset of eight of the total number of possible combinations that illustrate the range of approaches that might be utilized. The themes addressed in this subset of Strategic Management Approaches are:

- No Action—Stabilize and Store
- Preferred Alternative
- Minimizing Total Process Duration at Rocky Flats
- Minimize Cost
- Conduct all Processing at Rocky Flats
- Conduct the Fewest Actions at Rocky Flats
- Selection of Processes Yielding the Greatest Amount of Plutonium Separation
- Selection of Processes without Plutonium Separation.

The specific material category/technology/site combinations that were used to construct each of the Strategic Management Approaches listed above are specified in Tables 2–2 through 2–4.

The environmental impacts that would result from implementation of each of the Strategic Management Approaches were obtained by summing the impacts that would occur due to each of the individual material category/technology/site combinations used to construct a particular alternative or approach. A similar process could be used to determine the impacts of any other Strategic Management Approach that a reader might wish to consider. Comparison of the impacts that would result from these various Strategic Management Approaches allow the reader to evaluate the sensitivity of the impacts to the major characteristics (e.g., cost, location of processing, plutonium separation vs. no separation, etc.) around which the Strategic Management Approaches were constructed.

The environmental impacts that would result from implementation of the eight Strategic Management Approaches are presented in Table 2–27 and in Section 4.22. The technologies and sites considered for each material category are described in detail in Sections 2.4.1 through 2.4.10.

In considering these Strategic Management Approaches, DOE requests the reader to keep in mind they are illustrative and are not intended necessarily to be the set of material category/technology/site combinations that would be selected in the Records of Decision. Rather, DOE expects that it will be more appropriate to determine what action to take, if any, by selecting the approach individually for each material category and then assembling these choices as the action to implement. This sort of selection is in fact presented in the Preferred Alternative, which is presented as one of the Strategic Management Approaches.

The strategic management approaches are discussed in more detail below.

2.5.1 No Action Alternative—Stabilize and Store

The stabilization technologies that represent the No Action Alternative are those analyzed in the Solid Residue Environmental Assessment (DOE 1996k). The stabilization of scrub alloy was not addressed in the Solid Residue Environmental Assessment. The No Action Alternative for scrub alloy is continued storage at Rocky Flats with repackaging, as necessary. Some of the materials may be subjected to more than one processing technology conducted in series (e.g., some of the incinerator ash may be calcined and then cemented or repackaged). For the purpose of analysis, all materials in the No Action Alternative are assumed to be stored for 20 years after stabilization. The material categories and the stabilization technologies used for the No

Action Alternative are listed in **Table 2–2** and are also discussed in the sections for each material category, Sections 2.4.1 through 2.4.10. All of the stabilization activities would occur at Rocky Flats.

Table 2–2 Stabilization Technology Used in No Action—Stabilize and Store for Each Material Category

Material	*No Action—Stabilize and Store Alternative*
Incinerator ash residues	Calcination followed by cementation or repackaging
Sand, slag, and crucible residues	Calcination followed by cementation or repackaging
Graphite fines residues	Calcination followed by cementation or repackaging
Inorganic ash residues	Calcination followed by cementation or repackaging
Molten salt extraction/electrorefining salt residues	Pyro-oxidation
Direct oxide reduction salt residues	Pyro-oxidation
Aqueous-contaminated combustible residues	Neutralize/dry
Organic-contaminated combustible residues	Wash/thermal desorption/steam passivation
Dry combustible residues	Repackage
Plutonium fluoride residues	Acid dissolution/process to plutonium oxide
High-efficiency particulate air filter media residues	Neutralize/dry
Ful Flo filter media residues	Neutralize/dry
Sludge residues	Filter/dry
Glass residues	Neutralize/dry
Graphite residues	Repackage
Inorganic (metal and others) residues	Repackage
Scrub alloy	Repackage

2.5.2 Preferred Alternative

DOE has identified a preferred processing technology for each of the Rocky Flats plutonium residues and scrub alloy material categories. The material categories and DOE's Preferred Alternative are listed in **Table 2–3** and are also discussed in the sections for each material category, in Section 2.4, including DOE's reasons for selecting these processing technologies.

DOE's Preferred Alternative includes processing technologies for several material categories that would involve separation of plutonium from the materials as plutonium metal or oxide at either the Savannah River Site or Los Alamos National Laboratory. These sites have unique facilities and processing expertise for separating plutonium from certain categories of the residues and scrub alloy that are not available at Rocky Flats. The processing technologies involving separation are proposed not only because they will allow DOE to stabilize the residues and scrub alloy (to address near-term health and safety issues associated with storage of the materials), and would convert the materials into forms that would allow their disposal or other disposition (thus eliminating the continuing health and safety risks that would be associated with their continued storage), but would also address health and safety concerns related to the increased worker radiation doses associated with the non-separation processing technologies for these categories of residues and scrub alloy. The Savannah River Site facilities for the separation of plutonium include the H-Canyon, HB-Line, F-Canyon, and the FB-Line. Use of these facilities, some of which are designed for remote operation, would result in lower worker radiation exposure than use of the glovebox facilities at Rocky Flats, low technical uncertainty, or low cost. Separation of plutonium from pyrochemical salt residues at Los Alamos National Laboratory would not be remote-handled, but would involve much shorter time exposures of the workers to the residues than would the nonseparation technology. Any plutonium separated would be disposed of using an immobilization process.

Table 2–3 Preferred Processing Technology and Site for Each Material Category

Material Category	*Preferred Alternative (Draft EIS)*	*Preferred Alternative (Final EIS)*
Ash Residues		
Incinerator Ash	Vitrification at Rocky Flats (see Section 2.4.1 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.1)
Sand, Slag and Crucible	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (see Section 2.4.1 of Draft EIS)	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (Alternative 3) (see Section 2.4.1)
Graphite Fines	Vitrification at Rocky Flats (see Section 2.4.1 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.1)
Inorganic	Vitrification at Rocky Flats (see Section 2.4.1 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.1)
Pyrochemical Salt Residues		
Molten Salt Extraction/Electrorefining (IDC 409 Only)	Salt Distillation at Rocky Flats (see Section 2.4.2 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.2)
Molten Salt Extraction/Electrorefining (All Others)	Salt Distillation at Rocky Flats (See Section 2.4.2 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (See Section 2.4.2)
Direct Oxide Reduction (IDCs 365, 413, 417, and 427)	Pyro-oxidation at Rocky Flats and Water Leach at Los Alamos National Laboratory (See Section 2.4.2 of Draft EIS) (No Action for some)	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at Los Alamos National Laboratory (Alternative 3) and Repackage at Rocky flats (Alternative 4) (See Section 2.4.2)[a]
Direct Oxide Reduction (All Others)	Pyro-oxidation at Rocky Flats and Water Leach at Los Alamos National Laboratory (See Section 2.4.2 of Draft EIS) (No Action for some)	Repackage at Rocky Flats (Alternative 4) (See Section 2.4.2)
Combustible Residues		
Aqueous-Contaminated	Neutralize/Dry at Rocky Flats (See Section 2.4.3 of Draft EIS)	Neutralize/Dry at Rocky Flats (Alternative 4) (See Section 2.4.3)
Organic-Contaminated	Thermal Desorption/Steam Passivation at Rocky Flats (see Section 2.4.3 of Draft EIS)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4) (see Section 2.4.3)
Dry	Repackage at Rocky Flats (see Section 2.4.3 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.3)
Plutonium Fluoride Residues		
Plutonium Fluoride	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (see Section 2.4.4 of the Draft EIS)	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (Alternative 3) (see Section 2.4.4)
Filter Media Residues		
Ful Flo Filter Media (IDC 331)	To be determined	Blend Down at Rocky Flats (Alternative 2) (see Section 2.4.5)
High-Efficiency Particulate Air Filter Media (IDC 338)	To be determined	Neutralize/Dry at Rocky Flats (Alternative 4) (see Section 2.4.5)
High-Efficiency Particulate Air Filter Media (All Others)	To be determined	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.5)
Sludge Residues		
(IDCs 089, 099, and 332)	To be determined	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.6)

Material Category	*Preferred Alternative (Draft EIS)*	*Preferred Alternative (Final EIS)*
All Other Sludges	To be determined	Filter/Dry at Rocky Flats (Alternative 4) (see Section 2.4.6)
Glass Residues		
Glass	Neutralize/Dry at Rocky Flats (see Section 2.4.7 of Draft EIS)	Neutralize/Dry at Rocky Flats (Alternative 4) (see Section 2.4.7)
Graphite Residues		
Graphite	Repackage at Rocky Flats (see Section 2.4.8 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.8)
Inorganic (Metal and Other) Residues		
Inorganic (Metal and Other)	Repackage at Rocky Flats (see Section 2.4.9 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (See Section 2.4.9)
Scrub Alloy		
Scrub Alloy	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (see Section 2.4.10 of Draft EIS)	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (Alternative 3) (see Section 2.4.10)

[a] There are two preferred processing technologies for the high plutonium concentration direct oxide reduction salt residues (IDCs 365, 413, 417, and 427). The rationale for having two preferred processing technologies is given in Section 2.4.2.

2.5.3 Other Management Approaches

In addition to the No Action Alternative and the Preferred Alternative, DOE constructed six other illustrative combinations of selected technologies and sites for each residue and scrub alloy material category as examples of strategic approaches. While these combinations represent a range of reasonable strategic approaches, it is important to recognize that these are only six of a myriad of approaches that could have been constructed for the materials subject to this EIS. The combinations of technologies and sites were chosen to illustrate approaches that emphasize the following:

- Minimize total process duration at Rocky Flats
- Minimize cost
- Conduct all processing at Rocky Flats
- Conduct fewest actions at Rocky Flats
- Select processes yielding the greatest amount of plutonium separation
- Select processes without plutonium separation

The processing technologies and sites for each material category used to construct each alternative are shown in **Table 2–4**.

2.6 STORAGE METHODS AND ISSUES

In this EIS, storage is considered for two categories of materials: (1) plutonium residues and scrub alloy and (2) plutonium metal and oxides. Transuranic waste generated by the processing of plutonium residues and scrub alloy at Rocky Flats would be stored in approved storage facilities until this waste is shipped to WIPP for disposal. These facilities would have to be maintained until WIPP is available for accepting Rocky Flats transuranic waste. A delay in opening WIPP may delay the closure of these facilities and the Rocky Flats site. Furthermore, a delay in opening WIPP for disposal operations may cause Rocky Flats to run out of transuranic waste storage capacity and require construction of additional storage capacity. Other processing sites would

Table 2–4 Selected Management Approaches for Processing Rocky Flats Plutonium Residues and Scrub Alloy

Material Category	*Minimize Total Process Duration at Rocky Flats*[a]	*Minimize Cost*	*Conduct All Processes at Rocky Flats*	*Conduct Fewest Actions at Rocky Flats*[b]	*Process with Maximum Plutonium Separation*	*Process without Plutonium Separation*
Incinerator Ash Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Sand, Slag and Crucible Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Graphite Fines Ash Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Inorganic Ash Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4) [c]	Repackage at Rocky Flats (Alternative 4)
MSE/ER Salt Residues* (IDC 409)	Repackage at Rocky Flats (Alternative 4)	Salt Distill at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Salt Distill at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
MSE/ER Salt Residues (All Others)*	Salt Scrub at Rocky Flats and Purex at SRS (Alternative 3)	Salt Distill at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Salt Distill at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
DOR Salt Residues (IDCs 365, 413, 417, and 427)*	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Salt Scrub at Rocky Flats and Purex at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
DOR Salt Residues (All Others)*	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Water Leach at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Aqueous-Contaminated Combustible Residues*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Neutralize/Dry at Rocky Flats (Alternative 4)
Organic-Contaminated Combustible Residues*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4)
Dry Combustible Residues*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)

Material Category	*Minimize Total Process Duration at Rocky Flats*[a]	*Minimize Cost*	*Conduct All Processes at Rocky Flats*	*Conduct Fewest Actions at Rocky Flats*[b]	*Process with Maximum Plutonium Separation*	*Process without Plutonium Separation*
Plutonium Fluoride Residues	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Acid Dissolution/ Plutonium Oxide Recovery at Rocky Flats (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Blend Down at Rocky Flats (Alternative 2)
Ful Flo Filter Media Residues (IDC 331)*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	MEO at Rocky Flats (Alternative 3)	Blend Down at Rocky Flats (Alternative 2)
HEPA Filter Residues (IDC 338 Only)*	Vitrify at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Neutralize/Dry at Rocky Flats (Alternative 4)
HEPA Filter Residues (All Other HEPA Filters)*	Vitrify at Rocky Flats (Alternative 2)	Vitrify at Rocky Flats (Alternative 2)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Sludge Residues (IDCs 089, 099, and 332)*	Repackage at Rocky Flats (Alternative 4)	Vitrify at Rocky Flats (Alternative 2)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)[c]	Repackage at Rocky Flats (Alternative 4)
Sludge Residues (All Others)*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Filter/Dry at Rocky Flats (Alternative 4)	Filter/Dry at Rocky Flats (Alternative 4)	Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats (Alternative 3)	Filter/Dry at Rocky Flats (Alternative 4)
Glass Residues*	Vitrify at Rocky Flats (Alternative 2)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Neutralize/Dry at Rocky Flats (Alternative 4)
Graphite Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Inorganic (Metal and Other) Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Scrub Alloy	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Calcine and Vitrify at Rocky Flats (Alternative 2)[d]	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Calcine and Vitrify at Rocky Flats (Alternative 2)[e]

STL = Safeguards termination limits SRS = Savannah River Site MEO = Mediated electrochemical oxidation HEPA = High-efficiency particulate air LANL = Los Alamos National Laboratory

[a] Minimum time to process residues and scrub alloy at Rocky Flats for shipment to the Savannah River Site, Los Alamos National Laboratory, or WIPP. All residue and scrub alloy processing in Rocky Flats Building 707 would be on the minimum process time critical path.

[b] Repackaging for some of the materials would result in fewer actions at Rocky Flats than would processing at Savannah River Site or Los Alamos National Laboratory. This is the result of necessary preprocessing operations that would have to be performed at Rocky Flats prior to transport to Savannah River Site or Los Alamos National Laboratory.

[c] No process with plutonium separation is available.

[d] Calcination/vitrification is the only proposed processing technology for scrub alloy analyzed at Rocky Flats.

[e] Calcination/vitrification is the only proposed processing technology without plutonium separation analyzed for scrub alloy.

* DOE is evaluating or may apply variances from safeguards termination limits for these material categories. Materials receiving variances could be shipped to WIPP as transuranic waste.

also store any transuranic waste generated while processing Rocky Flats plutonium residues and scrub alloy at their sites until it could be shipped to WIPP.

2.6.1 Storage of Plutonium Residues and Scrub Alloy

DOE has provided guidance on the interim safe storage of plutonium-bearing solid materials (i.e., storage for 20 years or less) in *Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials* (DOE 1995b). These criteria were promulgated to provide a DOE-wide consistent approach to ensuring safe interim storage of these plutonium-bearing materials while effecting the DOE Implementation Plan for the Defense Nuclear Facilities Safety Board's Recommendation 94-1, dated February 28, 1995. The pipe component is the baseline storage container for plutonium residues that meets requirements for disposal at WIPP. Under Alternative 1 (No Action—Stabilize and Store) and Alternative 4 (Combination of Processing Technologies), stabilized residues (except combustible residues, plutonium fluoride residues, filter media residues, and sludge residues) and scrub alloy would be stored in pipe components. Plutonium oxide, which is converted from plutonium fluoride residues under Alternative 1, would be stored as described in Section 2.6.2, below. In addition, transuranic waste produced at Rocky Flats during processing under Alternative 2 (Processing without Plutonium Separation) and Alternative 3 (Processing with Plutonium Separation) may also be stored in pipe components.

The pipe component is a flanged, stainless-steel pipe measuring 15 or 30 cm (6 or 12 inches [in]) in diameter. A lid bolted to the flange allows the residue material to be sealed within the pipe, which is placed inside a 208-L (55-gal) storage drum (**Figure 2–13**). The pipe may be fitted with a high-efficiency particulate air filter vent to release any hydrogen gas produced by radiolysis of water or organic materials. The pipe component would be used for packaging fissile gram equivalent–limited materials to achieve maximum loading of TRUPACT-II shipping containers in a manner that would prevent intermixing and criticality concerns in the event of a transportation accident. The WIPP Disposal Phase Final Supplemental EIS (DOE 1997a) includes a discussion of the pipe component and incorporates loading TRUPACT-IIs to 2,800 fissile gram equivalents. Accordingly, the WIPP waste acceptance criteria are being revised to include the pipe component and this subsequent loading limit. The pipe component would also block radiation emitted by high americium content materials at Rocky Flats, allowing them to be classified as contact-handled transuranic waste.

Before placement in a pipe component, processed plutonium residues would be packaged in containers (e.g., “bagout bags” and “produce cans”) that provide additional barriers to control inadvertent release or dispersion of the materials. Produce cans are small sealed cans in which the material would be placed while in the glovebox. Bagout bags are the plastic bags used in removing containers from a glovebox.

Residues and scrub alloy awaiting transfer to another onsite facility or an offsite facility (Savannah River Site or Los Alamos National Laboratory) for further processing would be stored temporarily in one of a number of double-containment, intrasite packages. Prior to shipment offsite, the double-contained packages would be placed into Type B containers authorized by the U.S. Department of Transportation and DOE for shipment (Section 2.8.1).

2.6.2 Storage of Plutonium Metal and Oxides

Processing the residues and scrub alloy under Alternative 3 would result in stabilized plutonium metal or oxides, which would be placed into safe and secure storage at the generating site pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final EIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c).

Safe, long-term storage of plutonium is addressed by DOE-STD-3013-96, *DOE Standard: Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage* (DOE 1996f). This Standard establishes safety criteria for packaging plutonium metals and stabilized plutonium oxides to ensure safe storage for at least 50 years. The Standard applies to packaging for safe storage of plutonium metals, alloys, and oxides that contain at least 50 percent plutonium by mass. To meet the Standard, materials containing plutonium must be in stable forms and must be packaged in containers designed to maintain their integrity both under normal storage conditions and during anticipated handling accidents. The processes in Alternative 3 would produce plutonium metals and oxides that satisfy this Standard.

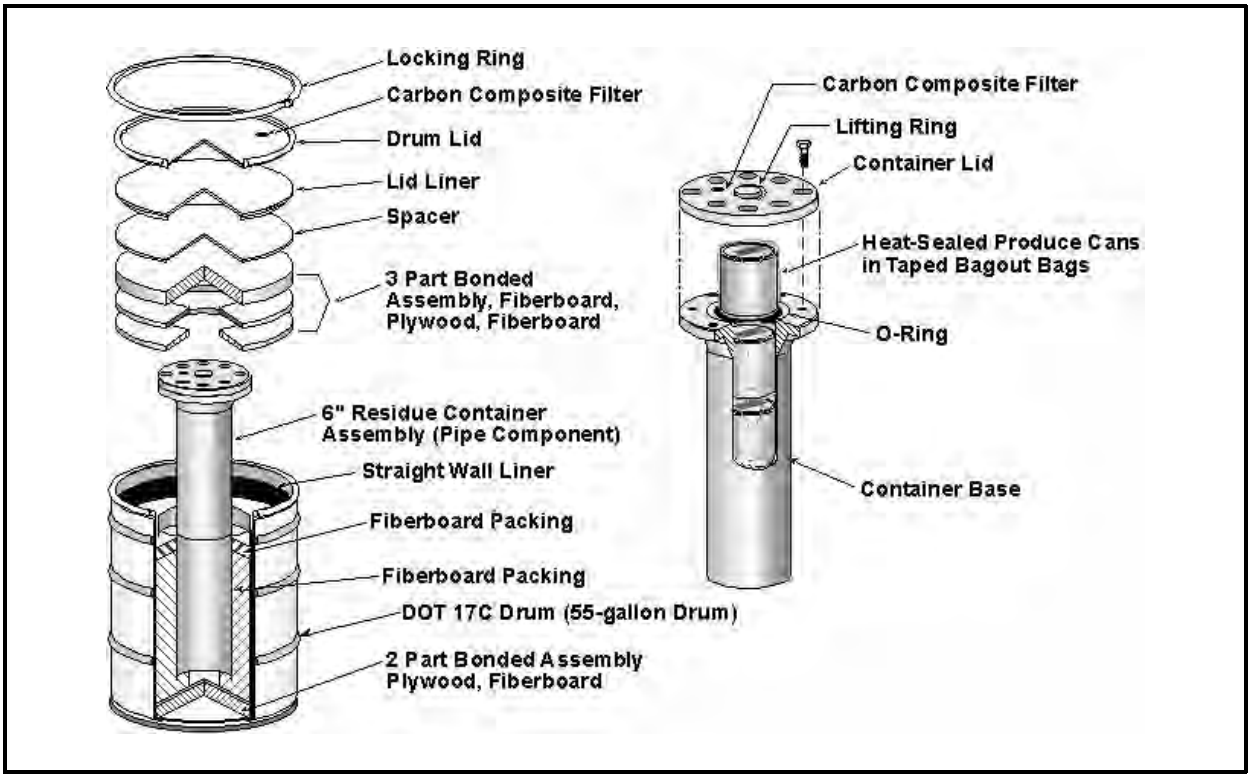

Figure 2–13 Pipe Component

2.7 DISPOSAL OR OTHER DISPOSITION

Under Alternative 1 (No Action Alternative), the plutonium residues and scrub alloy would be stabilized, repackaged and, placed in interim storage at Rocky Flats until DOE makes a final disposition decision. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE analyzed the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. A longer-term storage period was analyzed for transuranic waste for the No Action Alternative in the WIPP Disposal Phase Final Supplemental EIS (DOE 1997a). Under the Action Alternatives (i.e., Alternatives 2, 3, and 4), the residues and scrub alloy would either be processed and packaged in accordance with the WIPP waste acceptance criteria or, in the case of plutonium metal or oxide, would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in interim storage at the processing site pending disposition in accordance with decisions made after completion of the *Surplus Plutonium Disposition EIS* (DOE 1997c). During processing, some low-level or low-level mixed waste could be produced. These waste streams would be managed according to the waste management practices for these waste types at the processing site. At the Savannah River Site, liquid waste from the Purex

process would be placed in tanks with high-level waste. Solids from processing high-level waste would be vitrified and disposed of in the monitored geologic repository. Liquids would be converted into saltstone, which would be disposed of in onsite vaults.

2.7.1 Disposal of Transuranic Waste at WIPP

Transuranic waste generated from processing residues would be processed to meet the waste acceptance criteria for transuranic wastes required by WIPP (DOE 1996j). A summary of the nuclear and chemical properties of materials to meet these criteria is shown in **Table 2–5**. Some of the criteria are associated with hazardous wastes and are defined by the Resource Conservation and Recovery Act, including pyrophoric materials (reactive characteristic wastes); explosives and corrosive materials (ignitable, reactive, or corrosive characteristic wastes); and flammable volatile organic chemicals (ignitable characteristic wastes). The transuranic waste to be disposed of at WIPP would include processed residues from Alternatives 2 and 4 and most of the residual material generated in Alternative 3 after separation of plutonium metal or oxide. The environmental impacts of shipping transuranic wastes to WIPP and the impacts of disposal at that site are covered in the WIPP Disposal Phase Final Supplemental EIS (DOE 1997a). Transportation impacts are summarized and incorporated by reference in this EIS (see Appendix E, Section E.6.1).

For the purposes of this EIS, it is assumed that the TRUPACT-II shipping containers would be loaded with up to 2,800 fissile gram equivalents of plutonium-239 (up to 200 fissile gram equivalents of plutonium-239 per drum for each of 14 drums). The Nuclear Regulatory Commission (NRC 1997) certified the 2,800 fissile gram equivalents loading for the TRUPACT-II in February 1997, and the WIPP Supplemental EIS (DOE 1997a) analyzed the impacts of transporting the Rocky Flats waste utilizing this loading.

Table 2–5 Summary of Selected WIPP Waste Acceptance Criteria

Criterion	*Requirements*
Nuclear Criticality (plutonium-239 fissile gram equivalents)	Less than 200 fissile gram equivalents of plutonium-239 per drum Less than 2,800 fissile gram equivalents of plutonium-239 per TRUPACT-II[a]
Plutonium-239 Equivalent Activity	Less than or equal to 1,800 curies plutonium-239 equivalent activity for solidified/vitrified waste
Contact Dose Rate	Less than or equal to 200 millirem per hour
Thermal Power	Less than 40 watts per TRUPACT-II
Transuranic Alpha Activity	Greater than 100 nanocuries per gram of waste matrix
Pyrophoric Materials	Less than 1% radionuclide pyrophorics and no nonradionuclide pyrophorics
Explosives, Corrosives, and Compressed Gases	No compressed gases or ignitable, reactive, or corrosive wastes
Flammable Volatile Organic Chemicals	Less than or equal to 500 parts per million in container headspace

[a] This criterion was recently revised from 325 to 2,800 fissile gram equivalents of plutonium-239 per TRUPACT-II (DOE 1996j).

2.7.2 Disposition of Plutonium Oxide and Metal

Plutonium metal or oxide separated under Alternative 3 would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in safe, secure storage at the processing site pending disposition. In the Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final EIS (DOE 1997e), described in Section 1.5.6, DOE decided to pursue a two-fold strategy for plutonium disposition: (1) immobilization of some (and potentially all) of the plutonium in a glass or ceramic material for disposal in a monitored geologic repository pursuant to the Nuclear Waste Policy Act; and (2) burning of some of the

plutonium as mixed-oxide (MOX) fuel in existing, domestic commercial reactors, with subsequent disposal of the spent fuel in a monitored geologic repository pursuant to the Nuclear Waste Policy Act. In July 1998, DOE published a Draft EIS on Surplus Plutonium Disposition (DOE 1997c), described in Section 1.5.7, that analyzes the impacts of implementing this plutonium strategy. Any plutonium separated under any alternative analyzed in this EIS would be disposed of using the immobilization process.

2.8 TRANSPORTATION

Transportation of plutonium residues or scrub alloy to other sites for processing would not occur under Alternative 1 (No Action—Stabilize and Store), Alternative 2 (Processing without Plutonium Separation), or Alternative 4 (Combination of Processing Technologies) because all processing would occur at Rocky Flats. Under Alternative 3 (processing with plutonium separation), however, some plutonium residues and scrub alloy would be transported to other DOE sites for processing that involves plutonium separation. Transportation of other plutonium-bearing materials (e.g., plutonium metal, plutonium oxide, and transuranic waste) that may result from the separation processes analyzed in this EIS is analyzed in other DOE EISs (Sections 1.5.4, 1.5.6, and 1.5.7).

Plutonium residues and scrub alloy have been shipped safely for 25 years. During the weapons production years (1960s to 1989), about 70 truck shipments (3,800 kg or 8,400 lb) were made from Rocky Flats to the Savannah River Site. These shipments were made using the same Transportation Safeguards System used for transporting nuclear weapons and weapon components. This same transportation system could be used in shipments of Rocky Flats plutonium residues and scrub alloy that DOE might decide to make after completion of this EIS.

The number of shipments that potentially could be sent to the Savannah River Site or Los Alamos National Laboratory under Alternative 3 for each processing technology is shown in **Table 2–6**. These shipments cannot be added to obtain the total shipments because that would lead to double counting of some shipments. Incinerator ash may be processed using either the Purex process or the mediated electrochemical oxidation process at the Savannah River Site. Accordingly, the number of shipments of this material are given for both processes. Under the Preferred Alternative, Rocky Flats would make 39 shipments to the Savannah River Site (26 for sand, slag, and crucible residues; 7 for plutonium fluoride residues; and 6 for scrub alloy) and 3 shipments to Los Alamos National Laboratory for high plutonium concentration direct oxide reduction salt residues.

Table 2–6 Possible Shipments of Plutonium Residues and Scrub Alloy for Processing with Plutonium Separation

Material Category	*Process/Site*	*Shipments*
Incinerator Ash and Firebrick Fines[a] Residues	Purex at Savannah River Site	116
	Mediated Electrochemical Oxidation at Savannah River Site	86
Sand, Slag, and Crucible Residues	Purex at Savannah River Site	26
Graphite Fines Residues	Mediated Electrochemical Oxidation at Savannah River Site	7
Molten Salt Extraction/ Electrorefining Salt Residues	Salt Distillation at LANL - IDC 409	6
	Salt Distillation at LANL - All Other IDCs	44
	Purex at Savannah River Site (following scrub) - IDC 409	7
	Purex at Savannah River Site (following scrub) - All Other IDCs	15
Direct Oxide Reduction Salt Residues	Acid Dissolution or Water Leach at LANL - IDCs 365, 413, 417, and 427	3
	Acid Dissolution or Water Leach at LANL - All Other IDCs	10
	Purex at Savannah River Site (following scrub) - IDCs 365, 413, 417, and 427	3
	Purex at Savannah River Site (following scrub) - All Other IDCs	1

Material Category	Process/Site	Shipments
Combustible Residues	Not shipped	
Plutonium Fluoride Residues	Purex at Savannah River Site	7
Filter Media Resources	Not shipped	
Sludge Residues	Not shipped	
Glass Residues	Not shipped	
Graphite Residues	Mediated Electrochemical Oxidation at Savannah River Site	16
Inorganic (Metal and Others) Residues	Mediated Electrochemical Oxidation at Savannah River Site	4
Existing Scrub Alloy	Purex at Savannah River Site	6

LANL = Los Alamos National Laboratory; IDC = Item Description Code

[a] Firebrick fines would not be processed by the Purex process.

DOE provides a level of safety and health for DOE transportation operations that is equivalent to or greater than that provided by compliance with applicable Federal, State, Tribal, and local regulations. In addition to meeting applicable shipping containment and confinement requirements in 10 Code of Federal Regulations (CFR) Part 71 and 49 CFR, packaging for transport of this material must be certified separately by DOE (DOE 1994b).

Four aspects of ground transportation are discussed in the following sections: (1) the ground transportation system, (2) the ground transportation route selection process, (3) emergency planning, and (4) security considerations.

2.8.1 Ground Transportation System Descriptions

Currently, DOE anticipates that any transportation of the scrub alloy and those plutonium residues with the highest plutonium concentrations would definitely be required to use the Transportation Safeguards System and would be shipped using the Safe, Secure Trailer System, which is a secure system, some details of which are classified. Nevertheless, DOE is considering whether it would be possible to use commercial carriers for shipments of plutonium residues containing low concentrations of plutonium and whether there would be any advantage to such shipments. The quantitative risk analyses (presented in detail in Appendix E) has been performed for both the commercial and Safe, Secure Trailer System. In both cases, plutonium residues and scrub alloy would be shipped from Rocky Flats to other DOE sites in Type B containers. The containers used by DOE for these shipments are authorized or certified by the Department of Transportation, DOE, and the Nuclear Regulatory Commission.

In general, scrub alloy and plutonium-bearing residues would be shipped in Type B packaging, such as the double-containment 9968 or 9975 containers, or 6M containers, after the chemical-, form-specific certificate of compliance has been obtained from DOE. On January 30, 1998, DOE issued a certificate of compliance for the 9975 container for plutonium metal and oxide. The 6M and 9975 containers are shown in **Figure 2–14**. Some of the plutonium residues could also be transported in the TRUPACT-II, a reusable certified Type B shipping package for plutonium-bearing wastes. A cutaway view of the TRUPACT-II is shown in **Figure 2–15**. The TRUPACT-II containers were specifically designed to transport transuranic waste to WIPP.

2.8.1.1 The Safe, Secure Trailer System

The Safe, Secure Trailer System is an integral part of the Transportation Safeguards System operated by the DOE Transportation Safeguards Division for the DOE Office of Defense Programs. The Transportation

Safeguards System normally is used to transport nuclear weapons, nuclear weapons components, and special nuclear materials. The Safe Secure Trailer System is a specially designed 18-wheel tractor-trailer, shown in **Figure 2–16**, which incorporates various deterrents to prevent unauthorized removal of cargo. All Safe, Secure Trailer System components undergo periodic preventive maintenance inspections and extensive maintenance checks before every trip. Additionally, DOE conducts periodic audits and surveys to ensure DOE transportation system compliance with Department of Transportation regulations.

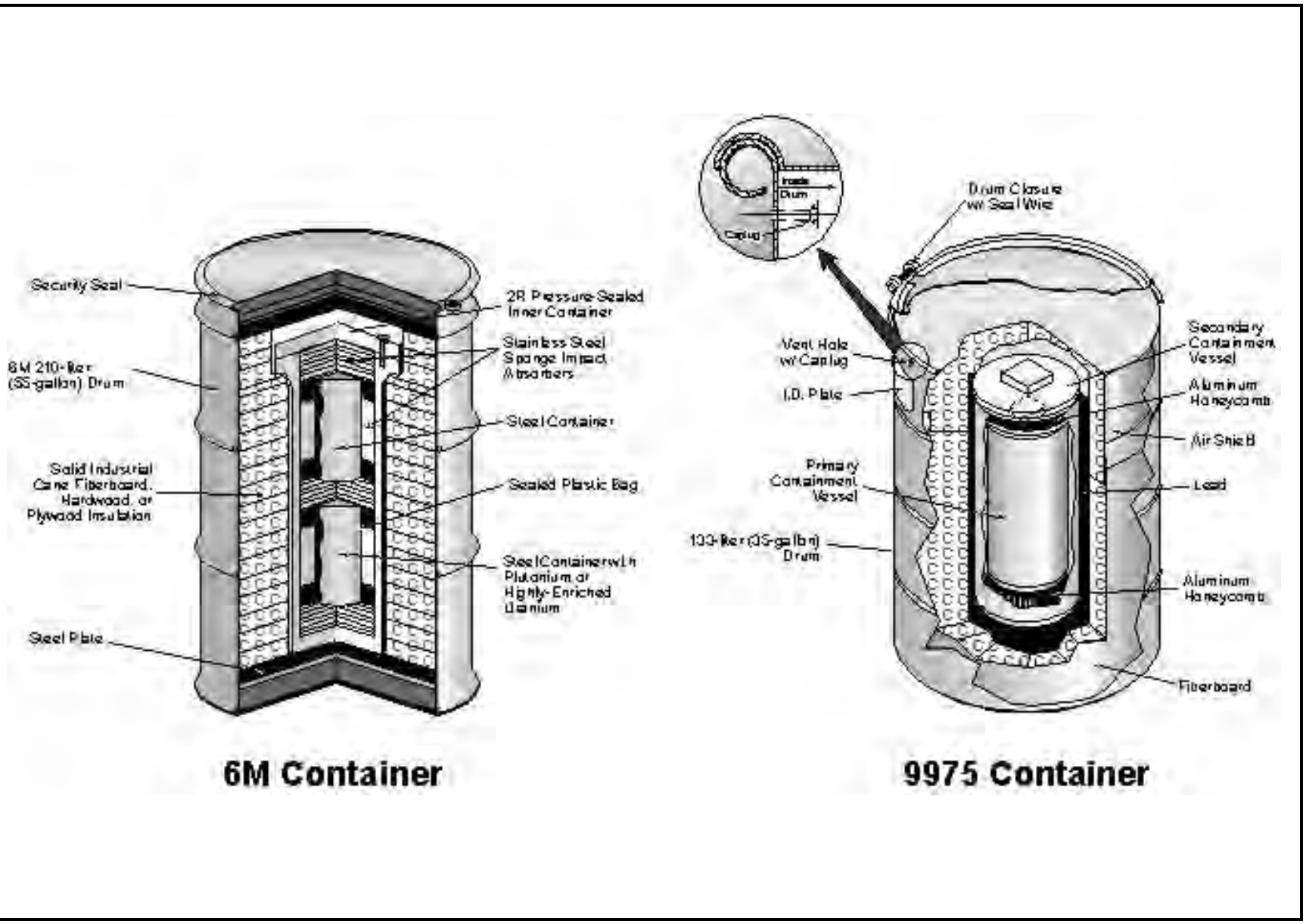

Figure 2–14 Type 6M and 9975 Transport Containers

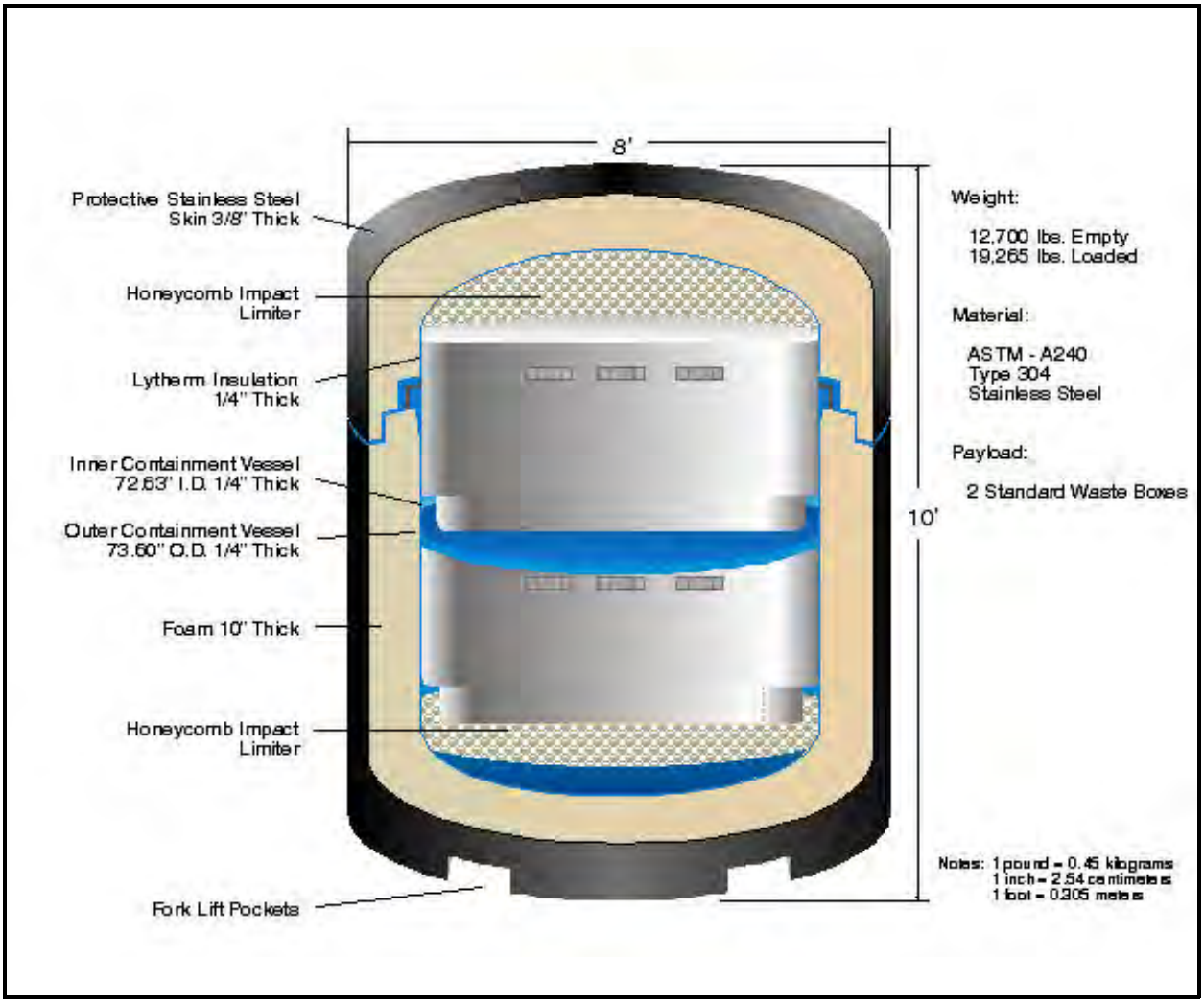

Figure 2–15 TRUPACT-II

2.8.1.2 The Commercial Transport System

The use of commercial transportation would be based on DOE's determination that the special protection and safety requirements mandated by the Nuclear Materials Safeguards Category (DOE 1994a) are not needed for a particular shipment (or shipments) because the amount of plutonium present does not require strict material control and accountability. The vehicles that would be used in this transportation system would meet maintenance and safety standards established by DOE Order 460.1A (DOE 1996d) and the Department of Transportation 49 CFR Part 396.

2.8.2 Ground Transportation Route Selection Process

DOE would develop the ground transportation routes for any residue or scrub alloy commercial shipments using a transportation planning process that would involve consultation with State and local officials.

Transportation Safeguards Division shipment routes are classified and are not publicly disclosed in order to protect national security interests. This EIS describes (in the following paragraphs) how nominal routes were chosen, based on Department of Transportation regulations incorporated in DOE Order 460.1A (DOE 1996d)

Figure 2–16 Safe, Secure Trailer System

and DOE Order 5610.12 (DOE 1994b). The actual route to be used for any shipment would be chosen based on a detailed and updated transportation planning process performed shortly before the shipment would occur. Commercial highway routing of nuclear material is systematically determined according to Department of Transportation regulations 49 CFR Parts 171-179 and 49 CFR Part 397. The Department of Transportation routing regulations require that shipment of a "highway route controlled quantity" of radioactive material be transported over a preferred highway network, including interstate highways (with preference toward interstate system bypasses and beltways around cities) and State-designated preferred routes. A State or Tribe may designate a preferred route to replace or supplement the interstate system according to Department of Transportation procedures (DOT 1992).

Carriers of highway route controlled quantities are required to use the preferred network except near the beginning or end of the trip when moving from origin to the nearest interstate or from the interstate exit nearest the destination, when making necessary repair or rest stops, or when emergency conditions render the interstate unsafe or impassible. Travel times would be a primary criterion for selecting the preferred route for a shipment and would be the primary criterion for commercial shipments.

The HIGHWAY computer code may be used for selecting highway routes in the United States. The HIGHWAY database is a computerized road atlas that currently describes approximately 386,400 kilometers (240,000 miles) of roads, including the interstate system and all U.S.-designated highways. In addition, most of the principal State highways and many local and community roads are identified. The code is updated periodically to reflect current road conditions and has been benchmarked against reported mileages and observations of commercial truck firms. Features in the HIGHWAY code allow users to select routes

conforming to Department of Transportation regulations. Additionally, the HIGHWAY code contains data on population densities along the routes. The distances and populations from the HIGHWAY code are part of the information used for the transportation impact analysis (Appendix E).

Routes that may be used for the shipment of plutonium residues and scrub alloy were identified using the HIGHWAY code. These routes were selected for risk assessment purposes and do not necessarily represent the actual routes that would be used to transport nuclear materials in the future. Specific routes cannot be publicly identified in advance in part to protect national security interests. In addition, the selection of the actual route to be used would be accomplished near the time of shipment to allow the selection to consider environmental and other conditions that exist, or are predicted to exist, at the time of shipment. Such conditions might include adverse weather conditions, road conditions, bridge closures, and local traffic problems. For security reasons, details about a route would not be publicized before the shipment.

2.8.3 Emergency Management Considerations

Emergency management planning involves Federal, State, Tribal, and local governments and the general public. State, Tribal, and local agencies have responsibilities for responding to an incident involving a DOE shipment within their jurisdiction. Emergency response plans outline the organizations and their responsibilities; emergency response procedures describe how the plan would be implemented.

For ground shipments of nonweapon-related nuclear materials (including the materials addressed in this EIS), State, Tribal, and local jurisdictions along the transportation corridor review DOE's plans and procedures for response to promote their consistency with State and local actions. DOE offers a variety of emergency response resources and information to supplement the existing response system. The States and DOE have conducted evaluations to determine the current radiological response capabilities and training necessary to maintain and improve existing capabilities to allow personnel to respond effectively to a possible shipment incident.

The DOE Transportation Safeguards Division regularly conducts drills and exercises as part of their training program. DOE developed an exercise program that provides an opportunity to evaluate State and local capabilities. Exercises can enhance learning, test systems, increase awareness, and provide information to evaluate the effectiveness of training. Exercises range from table-top to full-scale exercises. Transportation exercises are held on a rotational basis among the States as needed. Transportation accident exercises are held to test DOE response capabilities and local and State systems.

DOE monitors the status and location of the shipments while maintaining 24-hour, real-time communication with every convoy. In the event of an emergency, convoy escorts would immediately contact the DOE Emergency Operations Center, which would then alert the State or local authorities designated by the States as points of contact for such emergencies. The Emergency Operations Center would also contact DOE emergency response teams, as appropriate. Law enforcement agencies in each State have been provided information on how to respond to a shipment emergency.

As part of the process of preparing this EIS, DOE met with State and local officials from affected States in Kansas City, Missouri, on April 15 and 16, 1997, and in Nashville, Tennessee, on May 7 and 8, 1997, to discuss the potential shipments of Rocky Flats plutonium residues and scrub alloy to other DOE sites for processing. Although the timing and exact routes of these shipments would be classified because of the quantities of plutonium they contain, DOE reviewed its emergency response procedures and solicited participant responses on improvements to its shipping program. DOE is fully committed to working with the State and local communities along the transportation routes to promote the safe passage of these potential shipments.

2.8.4 Security Considerations

The objective of a security system is to analyze security risks and protect against them. It is designed to detect, communicate, and respond to an incident or adversarial act directed at the shipment of nuclear material, and it may include equipped, armed (e.g., for nuclear weapons and related components), and trained escorts accompanying the shipment.

A physical security system is implemented by DOE to address health and safety considerations, to facilitate rapid response to incidents, to minimize the possibilities for theft or radiological sabotage of nuclear material, and to facilitate the location and recovery of shipments that may have come under control of unauthorized persons. Following an incident or detection of a threat directed against the shipment, measures typically are taken to communicate the incident or threat information to an emergency operations center and to initiate predetermined response actions. The measures may address neutralizing a malevolent act, recovering material, or mitigating the consequences of an incident. The security measures employed by DOE during operations with either the Commercial Transport System or the Safe, Secure Trailer System would ensure that health, safety, and environmental considerations during the transport of plutonium residues and scrub alloy would be addressed properly.

2.9 SITES, TECHNOLOGIES, AND ISSUES NOT ANALYZED

In developing the scope of this EIS, DOE considered many plutonium processing technologies, including those identified during the initial screening and evaluation process and the public scoping process, as well as four candidate processing sites. Many technologies were initially identified as having potential for processing the plutonium residues and scrub alloy because of the wide variety of chemical forms represented in the materials. This initial screening process for selecting technologies for analysis in this EIS is described briefly in the following section. As a result of the screening process and other factors discussed in the section below, DOE determined that many of the technologies that are considered technically feasible are not feasible for all or certain material types. DOE's rationale for determining whether certain technologies and DOE sites were reasonable alternatives is discussed in Section 2.9.2. Issues identified during the public scoping process that are not analyzed or are out of scope are discussed in Sections 2.9.3 and 2.9.4, respectively.

2.9.1 Initial Screening and Evaluation Process

To determine which technologies to consider in the environmental analysis of the proposed action, DOE assembled a panel of DOE and contractor technical experts and managers who were familiar with the materials within the scope of the analysis, the state of the art in processing such materials, and the current capabilities and experience of the potential processing sites.

The panel chose the technologies described in the *Rocky Flats Solid Residue Environmental Assessment* (DOE 1996k) as the basis for Alternative 1 (No Action—Stabilize and Store) for the plutonium residues. However, since the Solid Residue Environmental Assessment did not address management of scrub alloy, which is in the scope of this EIS, a suitable No Action alternative had to be selected for scrub alloy. DOE chose to analyze repackaging, if necessary, and continue storage as the No Action alternative for scrub alloy, since this would represent the minimum action that would be required to maintain the scrub alloy in its present state and would be similar in scope to the actions selected for stabilization of the plutonium residues in the Finding of No Significant Impacts for the Solid Residue Environmental Assessment.

To determine which technologies to analyze under the action alternatives, the panel assembled by DOE used a screening process that started with a review of a wide range of potential processing technologies identified in a number of earlier DOE studies (additional information on these studies is located in Section 2.3 and

Appendix C). After identifying a preliminary set of potentially usable technologies from these studies, the DOE panel screened the technologies further using a set of criteria that included the following:

- Direct applicability of the technology to the particular material type
- Maturity and timing of the technology so that processing could be accomplished in the 1998 to 2004 timeframe or earlier to meet site closure targets within reasonable cost
- Experience of the DOE site in employing the technology and availability of the facilities and equipment
- Minimization of worker exposures
- Amount of secondary wastes generated and existence of appropriate secondary waste disposition methods

Next, several working sessions were held between DOE Headquarters and site technical and management representatives to better understand the suitability of the technologies to be applied to each material type, the experience of the sites with the technologies, and the capability of the sites to implement the technologies within the desired time frame. Based on these discussions, DOE identified the technologies discussed in Section 2.4 and Appendix C as reasonable technologies to include in this EIS.

The steps in the screening process described above are illustrated in **Figure 2–17.**

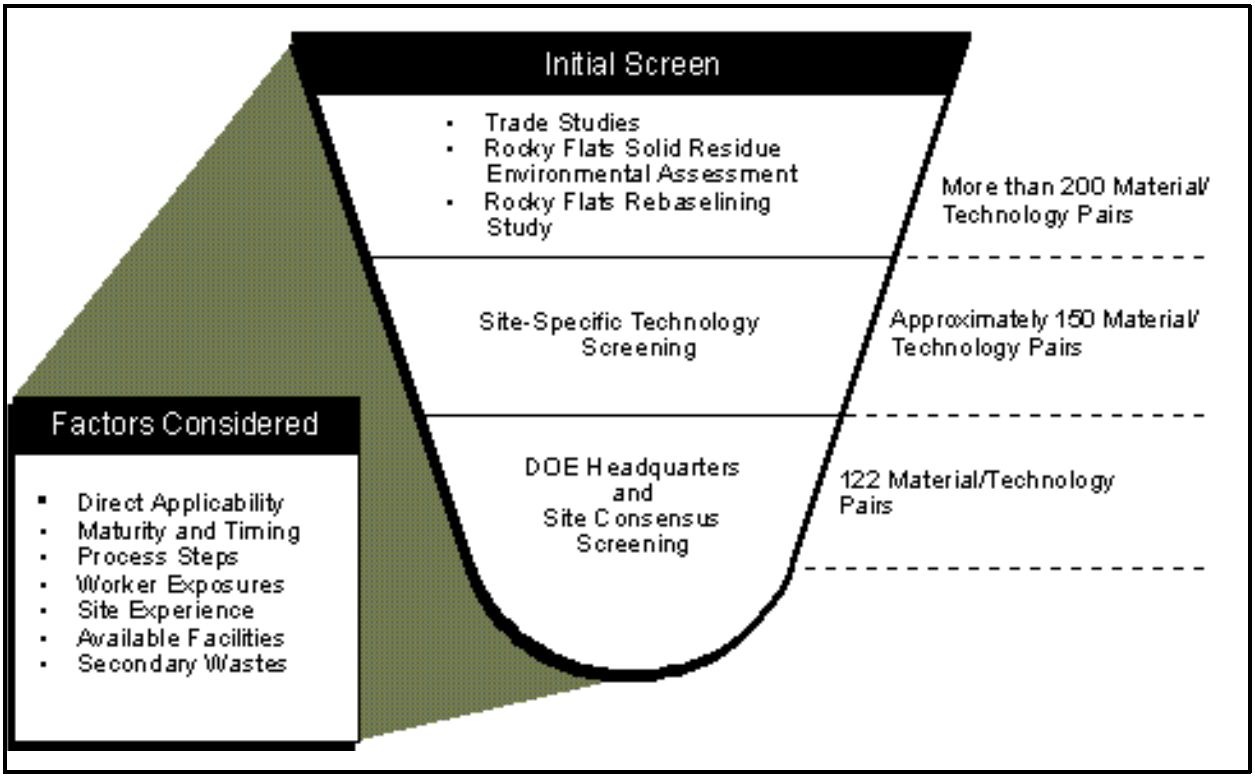

Figure 2–17 Material/Technology/Site Screening Process

2.9.2 Sites and Technologies Not Analyzed

This section discusses DOE's rationale for not further analyzing specific sites and technologies.

For Alternative 2 (Processing without Plutonium Separation), DOE is considering processing only at the Rocky Flats Site. Material transported to another site under this alternative would need to be stabilized, repackaged, or otherwise preprocessed before shipment. Because the material would be handled again at the processing site, this preprocessing would be an additional handling step that would increase costs and exposures, particularly to workers. Transportation from Rocky Flats to the processing site would increase the total materials transportation prior to disposition, thus increasing costs and total exposures to the general population and to transportation workers. DOE concluded that the preprocessing and transportation necessary to conduct processing without plutonium separation at another DOE site would increase risks and costs without providing any tangible benefits. For these reasons, DOE has determined that offsite processing without plutonium separation is unreasonable.

Lawrence Livermore and Los Alamos National Laboratories were initially considered for Alternative 3 (Processing with Plutonium Separation) because both sites have the capability to implement many of the technologies considered in this EIS. However, much of this capability is limited to laboratory bench scale operations suitable for initial development of the technology, but not for production operations. In addition, much of this limited processing capability is committed to other programs, including processing backlogs of residues from previous national laboratory operations.

Because of limitations discussed above, DOE concluded that it is unreasonable to consider the Los Alamos National Laboratory for processing most of the residue and scrub alloy at Rocky Flats. The EIS analyzes processing of pyrochemical salt residues only (for which Los Alamos National Laboratory has capabilities not found elsewhere) to preclude disrupting other ongoing Los Alamos National Laboratory activities.

The Lawrence Livermore National Laboratory has an administrative limit on the amount of plutonium that may be present there at any time that was established as a result of an agreement with the State of California. The existing plutonium inventory at Lawrence Livermore National Laboratory must be actively managed to remain under this administrative limit. This limitation would require that most or all of any residues processed at Lawrence Livermore National Laboratory be shipped an extra time, probably back to Rocky Flats, for storage. As a result of the limited capabilities and the administrative controls at the site, DOE has determined that it is unreasonable to consider Lawrence Livermore National Laboratory as a site for processing any of the Rocky Flats plutonium residues or scrub alloy.

DOE also determined that even though certain technologies for plutonium separation (Alternative 3) are feasible at some sites, the technologies are not reasonable options and are not analyzed in this EIS (see **Table 2–7**). The principal reasons for this determination were that: (1) the site has other important missions that compete for the site's limited processing capability (as discussed above), and (2) the potential processing site has limited storage capability for the plutonium residues and scrub alloy or for plutonium metal or oxides that result from processing. In particular, Los Alamos National Laboratory, Technical Area (TA)-55, as DOE's primary plutonium processing facility, has several Departmental missions that will utilize the capacity required for processing plutonium residues generated from multiple programmatic efforts. Combined with the site's limited available storage capacity, DOE determined that Los Alamos National Laboratory could only process a limited amount of plutonium residues from Rocky Flats to prevent adversely impacting the Department's other programmatic needs.

Table 2–7 Processing with Plutonium Separation: Technology/Site Combinations Not Analyzed[a]

Material Category	*Specific Technology*	*Site(s) Dismissed*
Incinerator Ash and Graphite Fines Residues	Mediated Electrochemical Oxidation	Rocky Flats
Molten Salt Extraction/Electrorefining Salts	Salt Distillation Salt Scrub	SRS SRS, LANL
Direct Oxide Reduction Salts	Water Leach Salt Scrub	SRS SRS, LANL
Plutonium Fluoride Residues	Acid Dissolution	LANL
Combustible Residues	Mediated Electrochemical Oxidation	SRS, LANL
High-Efficiency Particulate Air Filter Media Residues	Immobilization (Vitrification)	SRS
Graphite Residues	Mediated Electrochemical Oxidation	LANL
Inorganic Residues	Mediated Electrochemical Oxidation	LANL

[a] Refer to the text for the reasons that these technology/site combinations were not analyzed.
SRS = Savannah River Site
LANL = Los Alamos National Laboratory

The Savannah River Site was not considered further for separation processing of salt residues because its facilities are not designed to process material containing large quantities of chlorides. Combustible residues and wet residues such as high-efficiency particulate air filter media residues were not further considered for processing at any site other than Rocky Flats because potential radiolysis of these materials with resulting hydrogen gas generation limits the ability of DOE to transport these materials. Mediated electrochemical oxidation at Rocky Flats was not considered for removing plutonium from incinerator ash and graphite fines even though it was considered for several other plutonium residue material categories at Rocky Flats. The reason for this distinction is that Rocky Flats has the capability to process only small amounts of aqueous wastes in its liquid wastewater treatment system. The site could process the small quantity of liquid effluent that would result from mediated electrochemical oxidation processing of combustible residues, filter media residues, glass residues, graphite residues, and inorganic residues, but processing the large quantity of incinerator ash and graphite fines [approximately 15,000 kg (33,000 lb)] would produce more liquid effluent than the site could handle. Accordingly, mediated electrochemical oxidation of ash residues was dismissed as a technology at Rocky Flats.

This EIS does not consider application of a variance to safeguards termination limits for four materials: plutonium fluoride residues, high plutonium concentration direct oxide reduction salt residues, Ful Flo filter media residues, and scrub alloy. Plutonium fluoride residues have a high plutonium concentration. Repackaging this material and blending it down to the 10 percent plutonium concentration limit specified in the variance request was not considered because this procedure would expose workers to high neutron doses resulting from interactions between alpha particles emitted by plutonium and fluorine nuclei. A variance was not considered for high plutonium concentration direct oxide reduction salt residues and Ful Flo filter media residues in the Final EIS because the public was not informed in the Draft EIS that variances might be applied to these materials. DOE did not apply for a variance to the safeguards termination limit for scrub alloy because the high plutonium concentration in this material would require such extensive preprocessing (including substantial reduction of the plutonium concentration) that application of a variance is not a reasonable alternative.

2.9.3 Issues Raised During the Public Scoping Process That Are Not Analyzed

This section considers some alternatives, technologies, and other issues raised during scoping and briefly explains why they were eliminated from further analysis or otherwise were not included in this EIS.

- **Processing Residues Using the Glass Material Oxidation Dissolution System—**DOE eliminated the Glass Material Oxidation Dissolution System process from consideration because of timeliness and technical immaturity. The time required to complete the necessary research and development on technical issues (e.g., the melting process and the volume and quality of the glass products) precludes the use of the Glass Material Oxidation Dissolution System process within the 1998 to 2004 timeframe of analysis covered by this EIS.

- **Minimize Proliferation Risks through Vitrification and the "Spent Fuel Standard"—**The spent fuel standard is a concept that calls for surplus plutonium to be placed into a form that will withstand dissolution as well as spent fuel and has a radiation field, like spent fuel, that would deter access to the plutonium. This standard was put forth as a means to allow the safe disposal of fissile materials removed from nuclear weapons or fissile materials that have been purified to the point where they are suitable for use in nuclear weapons. In the plutonium residues covered by this EIS, plutonium is a minority constituent of a mixture of materials that would preclude direct use of the plutonium in a nuclear weapon. The process used to determine when such materials can be disposed of is to determine when they are in a form that is suitable for termination of safeguards. All of the plutonium separation technologies evaluated in the action alternatives in this EIS would ultimately result in conversion of the separated plutonium into either a glass or ceramic waste. The glass or ceramic waste form would then be embedded in logs of vitrified high-level radioactive waste, thus taking a form recognized as meeting the spent fuel standard.

  DOE considers processes that might convert the plutonium residues directly into a form that satisfies the spent fuel standard without first separating the plutonium from the residues not to be reasonable alternatives. First, to convert the plutonium residues directly to a form that satisfies the spent fuel standard at Rocky Flats, it would be necessary to transport high-level radioactive waste or the equivalent to Rocky Flats for use in "spiking" the waste form (i.e., adding a radiation source to the waste form to make it "self-protecting"). It also would be necessary to develop a new process and build new facilities, such as a vitrification plant, at the Rocky Flats site on an expedited basis, contrary to its current mission to clean up and shut down. Finally, it would be necessary to determine whether any waste form that might be produced would be acceptable for disposal in a geologic repository. Second, if the plutonium residues were to be converted directly into a form that meets the spent fuel standard at a site other than Rocky Flats, it would be necessary to develop and implement a new process and determine whether the final waste form that might be produced would be acceptable for disposal in a geologic repository.

  DOE concludes that there is no need to process the plutonium residues directly to the spent fuel standard to achieve nuclear weapons nonproliferation and disposition objectives for these materials, and that doing so would pose much greater difficulties than alternative means of achieving these objectives.

- **Process Scrub Alloy or Plutonium Residues Using Melt and Dilute Technology—**The melt and dilute technology is being considered by DOE as a step in the preparation of aluminum-based research reactor spent nuclear fuel for disposal, as an alternative to chemical separation. Since one of the alternatives for processing scrub alloy and plutonium residues in this EIS is chemical separation, it has been suggested that DOE should also consider application of the melt and dilute technology to the scrub alloy and plutonium residues.

  The melt and dilute technology focuses on developing techniques and equipment to mix aluminum and the aluminum-based fuel elements to form a dilute metal form that meets safeguards termination requirements and is suitable for shipment and storage. The system will have to deal with the specific characteristics of spent fuel, remote handling, and high-radiation fields. It has the advantage of being a single-step process,

although that step has complications inherent in high-temperature metallurgical processing of radioactive materials.

In considering this suggestion, DOE notes the composition of aluminum-based research reactor spent nuclear fuel is considerably different from scrub alloy or plutonium residues. By comparison to the scrub alloy, the spent fuel consists of aluminum structure/cladding, enriched uranium, fission products, and a small quantity of plutonium (typically less than 1 percent). Scrub alloy is an alloy of magnesium, aluminum, americium, and plutonium, with a plutonium content of about 30 percent. Some of the scrub alloy was produced by an experimental process and contains calcium/gallium or calcium/cerium, with no aluminum. The physical form of the spent fuel is relatively long, fabricated fuel elements, whereas the form of the scrub alloy is approximately 3-inch diameter, extremely contaminated "buttons," encased in several layers of protective containment. These wide differences in physical composition, properties, and forms argues that there is no simple basis for concluding that a technology that works for aluminum-based spent fuel would also work for scrub alloy.

The differences between spent fuel and plutonium residues are even more significant. Whereas the spent fuel and scrub alloy are both metals and might be expected to dissolve in aluminum (assuming no formation of intermetallics or precipitates) to form uniform products, residues are almost never non-refractory metals. Residues consist of a number of chemical forms, including oxides, ceramics, hydrocarbons, combustibles, glasses, and salts. While pyrochemical processing is possible to make these materials compatible with the metallurgical processes employed in the melt and dilute technology, the resulting materials would contain slags, precipitates, and inclusions and would never represent uniform, diluted products. The equipment would need to handle a large number of feed configurations and would require a considerable amount of research and development. Thus, melt and dilute technology is inappropriate for processing residues.

The development of the melt and dilute technology for aluminum-based spent fuel has progressed to the point where nonirradiated mock-up fuel elements have been melted and diluted in a prototype melter in laboratory studies. In these laboratory studies, the basic metallurgy and associated physical processes have been demonstrated to be feasible and workable. Nevertheless, even with this much development completed, the technology is not expected to be fully qualified for use until approximately 2004. No similar level of development exists with respect to scrub alloy. There has been no demonstration that the process will work for scrub alloy, much less any demonstration of the specific process technologies or equipment that would be required. Consequently, it is doubtful that the melt and dilute technology could be ready for implementation by the 2006 time frame scheduled for the shut down of Rocky Flats. In consideration of these facts, DOE believes that melt and dilute technology is not appropriate to consider as a technology for processing scrub alloy or plutonium residues.

However, DOE is considering another dilution technology for scrub alloy in this EIS that does not involve plutonium separation—the calcination/vitrification process. DOE believes that this is a better process than the melt and dilute technology for scrub alloy because the technology is more mature and could be implemented with minimal changes at Rocky Flats by 2006. Furthermore, it satisfies the same objectives as the melt and dilute process, i.e., to immobilize the material without separation of plutonium in such a manner as to meet the safeguards termination limits.

- **Thermal Destruction (Incineration) of Residues at Rocky Flats—**DOE initially considered fluidized bed incineration for thermal destruction of combustible and filter media residues at Rocky Flats in the Draft EIS. Although this technology was demonstrated in previous Rocky Flats operations and at other sites, it has not been demonstrated under current Clean Air Act permitting standards. In addition, location of the facility in Building 776 has significant programmatic risk because of the condition of the facility and its

schedule for decommissioning. Restart of the facility would require expenditures for updating equipment and procedures that could not be justified by the limited quantity of material that would be processed. Because of the uncertainty of the permitting process for a new or restarted facility, the estimated time to deploy this operation would be four years or more after the issuance of the Record of Decision for this EIS. Thus, DOE considers this technology to be unreasonable at Rocky Flats and has eliminated it from further consideration.

- **Construct a New Vitrification Facility at Rocky Flats—**DOE does not consider the construction of a large-scale vitrification facility at Rocky Flats to be economically or technically justifiable given the relatively small amounts of material requiring vitrification at the site. The "furnace vitrification" technology proposed for use at Rocky Flats produces a processed material that is encapsulated rather than incorporated in a glass matrix and would meet the specifications for terminating safeguards.

- **Processing at Rocky Flats Followed by Shipment Offsite for Storage—**Shipment of processed Rocky Flats plutonium residues and scrub alloy offsite for interim storage pending disposition would involve additional shipping and result in additional impacts due to extra material handling. Shipment of processed plutonium residues and scrub alloy to another site for storage would involve the additional steps of loading the materials onto trucks at Rocky Flats, shipping to another site, unloading and placing the material into storage, and potentially having to move the material again to WIPP or another DOE site for disposition. In addition, DOE's decision on storage of plutonium, as stated in the *Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1997e), is to consolidate storage of weapons-usable plutonium by upgrading and expanding existing and planned facilities at the Pantex Plant in Texas and the Savannah River Site in South Carolina. For these reasons, processing at Rocky Flats and shipment offsite for storage is not analyzed.

- **Construction of a New Long-Term Storage Facility at Rocky Flats—**DOE believes that long-term storage of the plutonium residues and scrub alloy at Rocky Flats is not a reasonable alternative that should be considered in this EIS for the following reasons. Long-term storage of plutonium residues and scrub alloy at Rocky Flats is not consistent with the site's cleanup and closure mission and also does not satisfy the purpose and need for agency action described in this EIS. Specifically, DOE has committed to removing all plutonium from Rocky Flats based on: the *Final Rocky Flats Cleanup Agreement* among the State of Colorado, DOE, and the U.S. Environmental Protection Agency (EPA) for Rocky Flats (CDPHE 1996); the proximity of Rocky Flats to the Denver metropolitan area; and the fact that none of the Rocky Flats facilities are in suitable condition for long-term storage. Although DOE considered development of a new plutonium storage facility (see Section 1.6), this is no longer reasonable because of DOE's decision to disposition these materials either through deep geologic disposal of the transuranic waste at WIPP or disposition of any separated plutonium in accordance with decisions under DOE's *Record of Decision on the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* [DOE 1997e] and the *Surplus Plutonium Disposition Environmental Impact Statement* [DOE 1998]. In the event of significant delays in implementing these disposal or disposition methods, DOE would need to reevaluate its storage options.

- **Use of Decommissioned Minuteman Silos for Long-Term Storage of Plutonium Residues and Scrub Alloy—**DOE does not consider the use of one or more decommissioned Minuteman missile silos to store the plutonium residues or scrub alloy to be a reasonable alternative. The Strategic Arms Reduction Treaty, signed in July 1991, requires that the United States and the former Union of Soviet Socialist Republics destroy the missile silos covered by the treaty to ensure that they have been taken out of service. DOE does not want to create new DOE nuclear sites while attempting to close existing sites. Furthermore, missile silos have neither the facilities required to support the operations involved in the long-term storage of

processed residues or scrub alloy, nor the capabilities for emergency response following potential accidents. The costs and regulatory requirements associated with the provision of these capabilities could be very high.

2.9.4 Issues Raised During the Public Scoping Process That Are Out of Scope

In this section, DOE briefly discusses five issues that were raised during the scoping process that it considers to be out of the scope of this EIS.

Issue 1: Reprocessing should be restarted for spent fuel from nuclear power plants. On-site basins are full, and spent fuel should not be considered waste.

DOE Response: This EIS addresses only Rocky Flats' plutonium residues and scrub alloy and, thus, does not address spent fuel.

Issue 2: DOE is overreliant on WIPP as a disposal option. Problems cited include the following:

- WIPP has not been demonstrated to be a safe disposal site and may never be proven safe.
- The opening of WIPP is uncertain (there have been delays in past; it may never open).
- Basing plans on WIPP could result in unsafe storage at Rocky Flats unless DOE plans contingencies.
- The residues and scrub alloy should be stored in a monitored, retrievable manner—which is not so with WIPP.
- Burial eliminates or strongly hinders the possible use of future cleanup technologies.
- WIPP is on Native American lands, and DOE should not push this material onto other people who have been "marginalized."
- WIPP has a pressurized brine reservoir, and there is a possibility of a breach into the environment.
- The salts at WIPP are not dry and are thus corrosive.
- Fault lines exist at WIPP which can create vertical passageways for pressurized leaking waste.
- WIPP must be shown to limit radionuclide transport for 10,000 years—plutonium has a half-life of 24,000 years, which means it remains dangerous for several hundreds of thousands of years.
- Transportation to WIPP is a problem because of the increased risks from transportation and inappropriate emergency planning along the thousands of miles along the route to WIPP.

DOE Response: This EIS addresses only the preparation of the plutonium residues and scrub alloy prior to their disposal or other disposition in accordance with the Final Supplemental WIPP EIS (DOE 1997a) and with final decisions made for disposition of the nation's surplus weapons-usable plutonium stockpile (*Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, [DOE 1997a] and the *Surplus Plutonium Disposition Draft Environmental Impact Statement* [DOE 1998]). If the opening of WIPP were delayed, construction of additional storage capacity at Rocky Flats may be required. This EIS does not address issues associated with disposal at WIPP or other disposition of Rocky Flats plutonium residues and scrub alloy or their transportation to WIPP.

On May 13, 1998, the EPA issued a final rulemaking that certified that the WIPP complies with the radioactive waste disposal regulations set forth at Subparts B and C of 40 CFR Part 191 (EPA 1998). The EPA also is amending the WIPP compliance criteria (40 CFR 194) by adding Appendix A that describes EPA's certification, incorporating the approval processes for waste generator sites to ship waste for disposal at WIPP. The environmental impacts of opening or not opening WIPP are analyzed in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997a). This is the second

supplemental EIS on WIPP. This document and its preceding documents address the impacts of operating WIPP and the impacts of transporting waste materials to WIPP, including transportation of wastes to WIPP from Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory.

WIPP startup has been delayed by litigation. Radioactive waste disposal operations will begin after all legal issues have been settled. The opening of WIPP remains a high priority within DOE.

Issue 3: DOE should include in its proposed action the disposition of the enormous quantities of U-235 within the DOE complex because they pose the same level of proliferation risk as plutonium. The same controls over the materials and disposition should apply.

DOE Response: This EIS addresses only a specific amount of plutonium residues and scrub alloy at Rocky Flats that need to be processed to meet safeguards termination limits (see Chapter 1 and Appendix B of this EIS). The management and disposition of highly enriched uranium is addressed in DOE's *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE 1996i) and its Record of Decision (DOE 1996h).

Issue 4: Rocky Flats needs stricter cleanup standards and should expeditiously decontaminate and decommission its facilities. The surrounding communities have already been adversely impacted by Rocky Flats's past activities. DOE should address contamination from past accidents and fires at the site.

DOE Response: This EIS analyzes the impacts of managing certain Rocky Flats plutonium residues and scrub alloy (see Chapter 4). Impacts from other site activities and cleanup standards for decommissioning and decontaminating Rocky Flats facilities are not within the scope of this EIS for decision-making purposes. Section 4.25 of Chapter 4, however, does analyze the cumulative impacts (impacts of the proposed action in this EIS along with other site activities) at the potential processing sites and the impacts of intersite transportation.

Issue 5: DOE must ensure funding will be provided for the alternatives selected (included comments for processing at the Savannah River Site and Rocky Flats). DOE must commit to a stable funding source and cover longer-term milestones; any decision should include a fully defined plan that includes a commitment for the necessary fiscal support.

DOE Response: Any commitment for funding must come from Congress. DOE will request the funding required to implement any decision that is made from this EIS and does not expect to commit to any course of action for which funding cannot reasonably be expected.

2.10 SUMMARY OF IMPACTS

In this section, DOE provides a summary of the products and wastes generated by each processing technology, as well as the chemical and radiological risks due to incident-free operations and transportation of each processing technology. The data for each material category or subcategory are presented in **Tables 2–8** through **2–26**. These data are discussed in detail in the appropriate sections of Chapter 4 (where the potential environmental impacts from processing each material category or subcategory are discussed), as shown in the following list:

Residue Category	*Impact Discussion*
Incinerator Ash Residues	Section 4.2
Sand, Slag, and Crucible Residues	Section 4.2
Inorganic Ash Residues	Section 4.2
Graphite Fines Residues	Section 4.2
Electrorefining and Molten Salt Extraction Residues	Section 4.3
Direct Oxide Reduction Salt residues	Section 4.3
Combustible Residues	Section 4.4
Plutonium Fluoride Residues	Section 4.5
High-Efficiency Particulate Air Filter Residues	Section 4.6
Ful Flo Filter Residues	Section 4.6
Sludge Residues	Section 4.7
Glass Residues	Section 4.8
Graphite Residues	Section 4.9
Inorganic Residues	Section 4.10
Scrub Alloy	Section 4.11

The estimates of health effects from radiation doses used in this EIS are based on the linear no-threshold theory of radiation carcinogenesis, which postulates that all radiation doses, even those close to zero, are harmful. A recent examination of low radiation studies has reported that no statistically significant low-dose radiation study was found to support the linear no-threshold theory (Polycove 1997). This finding is supported by the National Council of Radiation Protection and Measurements in a report on collective dose that states "...essentially no human data can be said to prove or even to provide direct support for the concept of collective dose with its implicit uncertainties of nonthreshold, linearity and dose-rate independence with respect to risk" (NCRP 1995). Accordingly, calculations of health impacts based on the linear no-threshold theory may overstate the actual impacts of low radiation doses and should be viewed as an upper bound on the potential health effects.

In addition to estimating the potential environmental impacts that may be obtained from processing each material category, DOE estimated the potential impacts from processing several combinations of selected technologies and sites for each residue and scrub alloy material category. These combinations, described in Section 2.5, include the No Action Alternative, DOE's Preferred Alternative, and six other combinations selected to illustrate particular management strategies. The potential environmental impacts for these alternatives are shown in **Table 2–27** and are presented in more detail in Sections 4.20 through 4.22.

DOE has also estimated key cumulative impacts at the potential processing sites and during intersite transportation for the Rocky Flats plutonium residues and scrub alloy. Cumulative radiological and hazardous chemical impacts at Rocky Flats are shown in **Tables 2–28** and **2–29**, respectively. Cumulative radiological and hazardous chemical impacts at the Savannah River Site are shown in **Tables 2–30** and **2–31**, respectively. Cumulative radiological impacts at the Los Alamos National Laboratory are shown in **Table 2–32**. The processes used at Los Alamos National Laboratory do not produce hazardous chemical emissions. The cumulative impacts for the three sites are described in more detail in Section 4.25.

Table 2–8 Impacts of Managing Incinerator Ash Residues

Impact	*Calcine/ Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Cold Ceramify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Calcine and Cement at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes								
Stabilized Residues (drums[a])	4,379	0	0	0	0	0	4,379[b]	**4,987[b]**
Transuranic Waste (drums[a])	1,310	5,428	5,379	6,430	743	846	1,310	**593**
High-Level Waste[c] (canisters[d])	0	0	0	0	4	26	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	890	901	0	**0**
Low-Level Waste (drums[a])	2,860	1,187	1,187	1,187	1,581	1,560	2,860	**1,187**
Saltstone (cubic meters)	0	0	0	0	1,351	670	0	**0**
Radiological Risks Due to Incident-Free Operations and Transportation								
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.2×10^{-10}	1.7×10^{-11}	1.9×10^{-11}	9.5×10^{-11}	5.5×10^{-6}	5.5×10^{-6}	1.2×10^{-10}	**1.0×10^{-11}**
Offsite Public Population Risk (number of latent cancer fatalities)	2.6×10^{-6}	7.0×10^{-7}	7.5×10^{-7}	2.0×10^{-6}	0.0058	0.0042	2.6×10^{-6}	**4.0×10^{-7}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.15	0.072	0.057	0.092	0.16	0.11	0.13	**0.036**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation								
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 1×10^{-9}	 N/E 6×10^{-10}	 N/E N/E	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.0015[e]	0.0011[e]	N/E	**N/E**
Maximally Exposed Individual Involved Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 2×10^{-8}	 N/E 8×10^{-9}	 N/E N/E	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	[e]	N/E	**N/E**

MEO = mediated electrochemical oxidation STL = Safeguards Termination Limits N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions
N/E = no emissions

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex and MEO processes would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–9 Impacts of Managing Sand, Slag, and Crucible Residues

Impact	*Calcine/Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site (Preferred Processing Technology)*	*Calcine and Cement at Rocky Flats*	*Repackage at Rocky Flats*
Products and Wastes						
Stabilized Residues (drums[a])	954	0	0	**0**	954[b]	773[b]
Transuranic Waste (drums[a])	278	1,175	1,394	**134**	278	278
High-Level Waste[c] (canisters[b])	0	0	0	**4**	0	0
Separated Plutonium (kg plutonium)	0	0	0	**128**	0	0
Low-Level Waste (drums[a])	607	242	242	**300**	607	607
Saltstone (cubic meters)	0	0	0	**357**	0	0
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.8×10^{-11}	2.3×10^{-12}	1.3×10^{-11}	**5.5×10^{-6}**	1.8×10^{-11}	1.4×10^{-12}
Offsite Public Population Risk (number of latent cancer fatalities)	3.6×10^{-7}	9.5×10^{-8}	2.9×10^{-7}	**0.0013**	3.9×10^{-7}	5.5×10^{-8}
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	**0.0008**	0.0008	0.0008
Involved Worker Population Risk (number of latent cancer fatalities)	0.023	0.010	0.013	**0.019**	0.020	0.0056
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	**N/A**	N/E	N/E
• Hazard Index	N/E	N/E	N/E	**2.0×10^{-9}**	N/E	N/E
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	**0.00034[e]**	N/E	N/E
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	**N/A**	N/E	N/E
• Hazard Index	N/E	N/E	N/E	**2.0×10^{-8}**	N/E	N/E
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	N/E	N/E

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–10 Impacts of Managing Graphite Fines Ash Residues

Impact	*Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Calcine and Cement at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	280	0	0	0	280[b]	**319[b]**
Transuranic Waste (drums[a])	87	350	414	57	87	**41**
High-Level Waste[c] (canisters[d])	0	0	0	2	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	73	0	**0**
Low-Level Waste (drums[a])	186	79	79	103	186	**79**
Saltstone (cubic meters)	0	0	0	43	0	**0**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.0×10^{-11}	1.4×10^{-12}	7.5×10^{-12}	5.5×10^{-6}	1.0×10^{-11}	**8.0×10^{-13}**
Offsite Public Population Risk (number of latent cancer fatalities)	2.1×10^{-7}	5.5×10^{-8}	1.6×10^{-7}	0.00035	2.1×10^{-7}	**3.2×10^{-8}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.012	0.0060	0.0072	0.0087	0.010	**0.0029**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	2×10^{-9}	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	0.00009[e]	N/E	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	2×10^{-8}	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	N/E	**N/E**

MEO = mediated electrochemical oxidation N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions
STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex and MEO processes would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–11 Impacts of Managing Inorganic Ash Residues

Impact	*Calcine/Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Calcine and Cement at Rocky Flatse*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes					
Stabilized Residues (drums[a])	637	0	0	637[b]	**725[b]**
Transuranic Waste (drums[a])	181	779	924	181	**77**
High-Level Waste (canisters[c])	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	**0**
Low-Level Waste (drums[a])	395	152	152	395	**152**
Radiological Risks Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	6.5×10^{-12}	9.0×10^{-13}	5.2×10^{-12}	6.5×10^{-12}	**5.5×10^{-13}**
Offsite Public Population Risk (number of latent cancer fatalities)	1.4×10^{-7}	3.8×10^{-8}	1.1×10^{-7}	1.4×10^{-7}	**2.2×10^{-8}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.010	0.0039	0.0052	0.0072	**0.0020**
Hazardous Chemical Impacts Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual					
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker					
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–12 Impacts of Managing Electrorefining and Molten Salt Extraction Salt Residues (IDC 409)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Salt Distill at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Salt Distill at Los Alamos National Laboratory*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	1,406	0	0	0	0	0	**1,410[b]**
Transuranic Waste (drums[a])	90	1,445	97	1,609	175	191	**90**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	0.1	**0**
Separated Plutonium (kg plutonium)	0	0	235	228	234	228	**0**
Low-Level Waste (drums[a])	157	157	157	3,665	263	198	**157**
Saltstone (cubic meters)	0	0	0	0	0	51	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	6.0×10^{-12}	9.0×10^{-12}	1.1×10^{-11}	5.5×10^{-11}	5.5×10^{-6}	5.5×10^{-6}	**1.0×10^{-11}**
Offsite Public Population Risk (number of latent cancer fatalities)	2.5×10^{-7}	3.7×10^{-7}	4.4×10^{-7}	1.4×10^{-6}	0.00008	0.00037	**4.1×10^{-7}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.042	0.078	0.024	0.057	0.017	0.033	**0.019**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	5×10^{-10}	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.00007[e]	0.00009[e]	**N/E**
Maximally Exposed Individual Worker							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	5×10^{-9}	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–13 Impacts of Managing Electrorefining and Molten Salt Extraction Salt Residues (Except IDC 409)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Salt Distill at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Salt Distill at Los Alamos National Laboratory*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	3,800	0	0	0	0	0	**3,800[b]**
Transuranic Waste (drums[a])	464	10,802	519	11,945	933	1,236	**464**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	1	**0**
Separated Plutonium (kg plutonium)	0	0	569	552	558	553	**0**
Low-Level Waste (drums[a])	842	842	842	27,600	1,660	1,151	**842**
Saltstone (cubic meters)	0	0	0	0	0	384	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public MEI Risk (probability of a latent cancer fatality)	1.3×10^{-11}	2.2×10^{-11}	2.6×10^{-11}	1.4×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	**1.3×10^{-11}**
Offsite Public Population Risk (number of latent cancer fatalities)	5.5×10^{-7}	9.0×10^{-7}	1.1×10^{-6}	3.2×10^{-6}	0.00060	0.00079	**5.5×10^{-7}**
MEI Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.092	0.19	0.059	0.14	0.094	0.081	**0.073**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public MEI							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	1×10^{-9}	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.00029[e]	0.00020[e]	**N/E**
MEI Worker							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	1×10^{-8}	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions STL = Safeguards Termination Limits MEI = Maximally exposed individual

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–14 Impacts of Managing Direct Oxide Reduction Salt Residues (IDCs 365, 413, 417, and 427)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Water Leach at LANL*	*Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Preferred Processing Technology)*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	583	0	0	0	**0**	0	**826[b]**
Transuranic Waste (drums[a])	40	708	792	847	**865**	89	**40**
High-Level Waste[c] (canisters[d])	0	0	0	0	**0**	0.1	**0**
Separated Plutonium (kg plutonium)	0	0	133	138	**138**	134	**0**
Low-Level Waste (drums[a])	58	58	1,788	1,855	**1,855**	78	**58**
Saltstone (cubic meters)	0	0	0	0	**0**	25	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	3.6×10^{-12}	5.0×10^{-12}	5.5×10^{-11}	5.5×10^{-6}	**5.5×10^{-6}**	5.5×10^{-6}	**1.1×10^{-11}**
Offsite Public Population Risk (number of latent cancer fatalities)	1.5×10^{-7}	2.2×10^{-7}	1.2×10^{-6}	0.000041	**0.000041**	0.00016	**4.5×10^{-7}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	**0.0008**	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.023	0.045	0.034	0.0058	**0.0074**	0.013	**0.011**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	**N/E**	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	**N/E**	3×10^{-10}	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	0.00004[e]	**0.00004[e]**	0.00004[e]	**N/E**
Maximally Exposed Individual Worker							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	**N/E**	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	**N/E**	3×10^{-9}	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions LANL = Los Alamos National Laboratory

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type. There are two preferred processing technologies for this material category. The rationale for having two preferred processing technologies is given in Section 2.4.2.

Table 2–15 Impacts of Managing Direct Oxide Reduction Salt Residues (Except IDCs 365, 413, 417, and 427)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Water Leach at LANL*	*Preprocess at Rocky Flats and Acid Dissolution/ Plutonium Oxide Recovery at LANL*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	306	0	0	0	0	0	**306[b]**
Transuranic Waste (drums[a])	56	1,384	1,550	1,613	1,637	156	**56**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	0.1	**0**
Separated Plutonium (kg plutonium)	0	0	49	50	50	49	**0**
Low-Level Waste (drums[a])	110	110	3,547	3,549	3,549	150	**110**
Saltstone (cubic meters)	0	0	0	0	0	50	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public MEI Risk (probability of a latent cancer fatality)	1.3×10^{-12}	1.9×10^{-12}	2.0×10^{-11}	5.5×10^{-6}	5.5×10^{-6}	5.5×10^{-6}	**1.3×10^{-12}**
Offsite Public Population Risk (number of latent cancer fatalities)	5.0×10^{-8}	8.0×10^{-8}	4.2×10^{-7}	0.00014	0.00014	0.000053	**5.0×10^{-8}**
MEI Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.016	0.017	0.012	0.012	0.015	0.015	**0.014**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public MEI • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 1×10^{-10}	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	0.00006[e]	0.00006[e]	0.00001[e]	**N/E**
MEI Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 1×10^{-9}	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions LANL = Los Alamos National Laboratory
STL = Safeguards termination limits MEI = Maximally exposed individual

[a] Standard 208-liter (55-gallon) drums.
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Some wastes from the Purex process would be managed as high-level waste.
[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.
[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.
Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–16 Impacts of Managing Combustible Residues

Impact	*Stabilize/Repackage and Store at Rocky Flats (No Action Processing Technology)*	*Sonic Wash at Rocky Flats*	*Catalytic Chemical Oxidation at Rocky Flats*	*Blend Down at Rocky Flats*	*MEO at Rocky Flats*	*Stabilize/Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	916	0	0	0	0	**916[b]**
Transuranic Waste (drums[a])	92	423	1,275	220	1,219	**92**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	21	**0**
Low-Level Waste (drums[a])	229	229	2,727	229	2,727	**229**
Radiological Risks Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.8×10^{-12}	3.5×10^{-12}	2.3×10^{-12}	1.5×10^{-12}	3.7×10^{-12}	**1.8×10^{-12}**
Offsite Public Population Risk (number of latent cancer fatalities)	4.1×10^{-8}	7.5×10^{-8}	4.8×10^{-8}	3.2×10^{-8}	8.0×10^{-8}	**4.1×10^{-8}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.013	0.0068	0.017	0.0027	0.0044	**0.0080**
Hazardous Chemical Impacts Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 6×10^{-11} N/E	 1×10^{-11} N/E	 N/E 5×10^{-11}	 N/E N/E	 N/E N/E	 **6×10^{-11}** **N/E**
Offsite Public Population Risk (number of cancer incidences)	<1	<1	N/E	N/E	N/E	**<1**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 3×10^{-9} N/E	 7×10^{-10} N/E	 N/E 3×10^{-9}	 N/E N/E	 N/E N/E	 **3×10^{-9}** **N/E**
Worker Population Risk (number of cancer incidences)	<1	<1	N/E	N/E	N/E	**<1**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–17 Impacts of Managing Plutonium Fluoride Residues

Impact	*Acid Dissolution/Plutonium Oxide Recovery and Storage at Rocky Flats (No Action Processing Technology)*	*Blend Down at Rocky Flats*	*Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site (Preferred Processing Technology)*
Products and Wastes				
Stabilized Residues (drums[a])	141	0	0	**0**
Transuranic Waste (drums[a])	333	3,923	333	**40**
High-Level Waste[b] (canisters[c])	0	0	0	**0.2**
Separated Plutonium (kg plutonium)	0	0	141	**141**
Low-Level Waste (drums[a])	750	60	750	**105**
Saltstone (cubic meters)	0	0	0	**18**
Radiological Risks Due to Incident-Free Operations and Transportation				
Offsite Public MEI Risk (probability of a latent cancer fatality)	2.2×10^{-11}	0	2.2×10^{-11}	**5.5×10^{-6}**
Offsite Public Population Risk (number of latent cancer fatalities)	4.9×10^{-7}	0	4.9×10^{-7}	**0.00036**
MEI Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	**0.008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.019	0.142	0.018	**0.029**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation				
Offsite Public MEI				
• Probability of a cancer incidence	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	**1×10^{-9}**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	**0.00009[d]**
MEI Worker				
• Probability of a cancer incidence	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	**2×10^{-8}**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	**[d]**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions MEI = maximally exposed individual

[a] Standard 208-liter (55-gallon) drums.

[b] Some wastes from the Purex process would be managed as high-level waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[d] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–18 Impacts of Managing Ful Flo Filter Residues (IDC 331)

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Blend Down at Rocky Flats (Preferred Processing Technology)*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*
Products and Wastes				
Stabilized Residues (drums[a])	1,517	**0**	0	0
Transuranic Waste (drums[a])	65	**269**	343	860
High-Level Waste (canisters[b])	0	**0**	0	0
Separated Plutonium (kg plutonium)	0	**0**	0	19
Low-Level Waste (drums[a])	166	**166**	166	1,919
Radiological Risks Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	2.1×10^{-12}	**1.4×10^{-12}**	2.8×10^{-12}	2.8×10^{-12}
Offsite Public Population Risk (number of latent cancer fatalities)	4.4×10^{-8}	**2.9×10^{-8}**	6.0×10^{-8}	6.0×10^{-8}
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	**0.0008**	0.0008	0.0008
Involved Worker Population Risk (number of latent cancer fatalities)	0.011	**0.0022**	0.0036	0.0025
Hazardous Chemical Impacts Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual				
• Probability of a cancer incidence	N/E	**N/E**	$7x10^{-12}$	N/E
• Hazard Index	N/E	**N/E**	N/E	N/E
Offsite Public Population Risk (number of cancer incidences)	N/E	**N/E**	<1	N/E
Maximally Exposed Individual Worker				
• Probability of a cancer incidence	N/E	**N/E**	4×10^{-10}	N/E
• Hazard Index	N/E	**N/E**	N/E	N/E
Worker Population Risk (number of cancer incidences)	N/E	**N/E**	<1	N/E

MEO = mediated electrochemical oxidation N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from preferred processing technology are presented in bold type.

Table 2–19 Impacts of Managing High-Efficiency Particulate Air Filter Residues (IDC 338)

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*	*Neutralize/Dry at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	3,223	0	0	0	0	**3,223[b]**
Transuranic Waste (drums[a])	138	656	572	730	1,827	**138**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	88	**0**
Low-Level Waste (drums[a])	360	360	360	360	4,085	**360**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	9.5×10^{-12}	2.1×10^{-12}	6.5×10^{-12}	1.3×10^{-11}	1.3×10^{-11}	**9.5×10^{-12}**
Offsite Public Population Risk (number of latent cancer fatalities)	2.0×10^{-7}	8.5×10^{-8}	1.3×10^{-7}	2.8×10^{-7}	2.7×10^{-7}	**2.0×10^{-7}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.033	0.0092	0.010	0.016	0.011	**0.016**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	3×10^{-11}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	2×10^{-9}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–20 Impacts of Managing High-Efficiency Particulate Air Filter Residues (Except IDC 338)

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	96	0	0	0	0	**87[b]**
Transuranic Waste (drums[a])	10	48	42	53	133	**10**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	2	**0**
Low-Level Waste (drums[a])	25	25	25	25	297	**25**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	2.1×10^{-13}	4.7×10^{-14}	1.4×10^{-13}	3.0×10^{-13}	2.9×10^{-13}	**2.2×10^{-14}**
Offsite Public Population Risk (number of latent cancer fatalities)	4.5×10^{-9}	1.9×10^{-9}	3.0×10^{-9}	6.5×10^{-9}	6.0×10^{-9}	**9.0×10^{-10}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.00084	0.00020	0.00068	0.00035	0.00026	**0.00064**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	7×10^{-13}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	4×10^{-11}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–21 Impacts of Managing Sludge Residues (IDCs 089, 099, and 332)

Impact	*Filter/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes				
Stabilized Residues (drums[a])	45	0	0	**6[b]**
Transuranic Waste (drums[a])	2	3	8	**2**
High-Level Waste (canisters[c])	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	**0**
Low-Level Waste (drums[a])	1	1	1	**1**
Radiological Risks Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	7.0×10^{-14}	2.3×10^{-14}	1.9×10^{-14}	**2.0×10^{-14}**
Offsite Public Population Risk (number of latent cancer fatalities)	1.4×10^{-9}	9.5×10^{-10}	8.0×10^{-10}	**8.0×10^{-10}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.00040	0.000092	0.000092	**0.000072**
Hazardous Chemical Impacts Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual				
• Probability of a cancer incidence	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker				
• Probability of a cancer incidence	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	**N/E**

N/E = no emissions

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–22 Impacts of Managing Sludge Residues (Except IDCs 089, 099, and 332)

Impact	*Filter/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats*	*Filter/Dry at Rocky Flats (Preferred Processing Technology)*
Products and Wastes					
Stabilized Residues (drums[a])	1095	0	0	0	**1,095[b]**
Transuranic Waste (drums[a])	60	216	212	653	**60**
High-Level Waste (canisters[c])	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	25	**0**
Low-Level Waste (drums[a])	127	127	127	1,468	**127**
Radiological Risks Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.8×10^{-12}	6.5×10^{-13}	1.8×10^{-12}	3.7×10^{-12}	**1.8×10^{-12}**
Offsite Public Population Risk (number of latent cancer fatalities)	3.9×10^{-8}	2.5×10^{-8}	3.9×10^{-8}	8.0×10^{-8}	**3.9×10^{-8}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.010	0.0026	0.0026	0.015	**0.0044**
Hazardous Chemical Impacts Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual					
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker					
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–23 Impacts of Managing Glass Residues

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*	*Neutralize/Dry at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	7	0	0	0	0	**7[b]**
Transuranic Waste (drums[a])	11	41	41	48	145	**11**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	5	**0**
Low-Level Waste (drums[a])	27	27	27	27	321	**27**
Radiological Risks Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	0	1.0×10^{-13}	3.6×10^{-13}	0	9.0×10^{-13}	**0**
Offsite Public Population Risk (number of latent cancer fatalities)	0	4.3×10^{-9}	7.5×10^{-9}	0	1.9×10^{-8}	**0**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.00064	0.00040	0.00044	0.00076	0.00076	**0.00060**
Hazardous Chemical Impacts Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–24 Impacts of Managing Graphite Residues

Impact	*Repackage and Store at Rocky Flats (No Action Processing Technology)*	*Cement at Rocky Flats*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*MEO at Rocky Flats*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	575	0	0	0	0	0	**575[b]**
Transuranic Waste (drums[a])	171	756	650	650	2,055	119	**171**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	8	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	95	96	**0**
Low-Level Waste (drums[a])	376	376	153	153	4,495	216	**376**
Saltstone (cubic meters)	0	0	0	0	0	104	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	0	1.4×10^{-12}	2.0×10^{-12}	6.8×10^{-12}	1.7×10^{-11}	5.5×10^{-6}	**0**
Offsite Public Population Risk (number of latent cancer fatalities)	0	3.0×10^{-7}	8.0×10^{-8}	1.4×10^{-7}	3.6×10^{-7}	0.00081	**0**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.010	0.014	0.0076	0.0076	0.014	0.017	**0.0072**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	2×10^{-9}	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	0.00021[e]	**N/E**
Maximally Exposed Individual Worker							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	2×10^{-8}	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	[e]	**N/E**

MEO = mediated electrochemical oxidation N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions
STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–25 Impacts of Managing Inorganic Residues

Impact	*Repackage and Store at Rocky Flats (No Action Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*MEO at Rocky Flats*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	106	0	0	0	0	**106[b]**
Transuranic Waste (drums[a])	37	119	120	485	24	**37**
High-Level Waste[c] (canisters[d])	0	0	0	0	1	**0**
Separated Plutonium (kg plutonium)	0	0	0	17	18	**0**
Low-Level Waste (drums[a])	94	40	40	1,075	52	**94**
Saltstone (cubic meters)	0	0	0	0	19	**0**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	0	4.2×10^{-13}	1.2×10^{-12}	3.2×10^{-12}	5.5×10^{-6}	**0**
Offsite Public Population Risk (number of latent cancer fatalities)	0	1.7×10^{-8}	2.6×10^{-8}	6.5×10^{-8}	0.0002	**0**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.0019	0.0015	0.0019	0.0030	0.0035	**0.0013**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	2×10^{-9}	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.0005[e]	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	2×10^{-8}	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	**N/E**

MEO = mediated electrochemical oxidation N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions
STL = Safeguards termination limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–26 Impacts of Managing Scrub Alloy

Impact	*Repackage and Store at Rocky Flats (No Action Processing Technology)*	*Calcine and Vitrify at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site (Preferred Processing Technology)*
Products and Wastes			
Repackaged Scrub Alloy (drums[a])	276	0	**0**
Transuranic Waste (drums[a])	59	2,809	**61**
High-Level Waste[b] (canisters[c])	0	0	**0.3**
Separated Plutonium (kg plutonium)	0	0	**200**
Low-Level Waste (drums[a])	140	140	**167**
Saltstone (cubic meters)	0	0	**103**
Radiological Risks Due to Incident-Free Operations and Transportation			
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	2.1×10^{-11}	3.2×10^{-11}	**5.5×10^{-6}**
Offsite Public Population Risk (number of latent cancer fatalities)	8.5×10^{-7}	1.2×10^{-6}	**0.00031**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.014	0.057	**0.024**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation			
Offsite Public Maximally Exposed Individual			
• Probability of a cancer incidence	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	**2×10^{-9}**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	**0.00008[d]**
Maximally Exposed Individual Worker			
• Probability of a cancer incidence	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	**2×10^{-8}**
Worker Population Risk (number of cancer incidences)	N/E	N/E	**[d]**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions

[a] Standard 208-liter (55-gallon) drums.

[b] Some wastes from the Purex process would be managed as high-level waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[d] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–27 Impacts of the Alternatives and Management Approaches

Impact	*Management Approaches*							
	No Action Alternative	***Preferred Alternative[a]***	***Minimize Total Process Duration at Rocky Flats***	***Minimize Cost***	***Conduct all Processes at Rocky Flats***	***Conduct Fewest Actions at Rocky Flats***	***Process with Maximum Plutonium Separation***	***Process without Plutonium Separation***
Products and Wastes								
Stabilized Residues (drums[a])	20,300	18,400[b]	8,900[b]	7,800[b]	19,200[b]	17,200[b]	700[b]	19,200[b]
Transuranic Waste [c] (drums [a])	3,500	3,200	6,600	3,400	5,600	3,200	9,300	9,200
High-Level Waste (canisters[d])	0	5	2	1	0	5	42	0
Separated Plutonium (kg)[e]	0	607	1,082	1,279	141	607	2,709	0
Low-Level Waste (drums[a])	7,500	6,400	10,400	4,900	5,500	6,400	19,900	4,800
Public and Occupational Health and Safety								
Incident-Free Radiological Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	2.4×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	5.5×10^{-6}	1.2×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	9.4×10^{-11}
Incident-Free Radiological Risk to the Public Population (Latent Cancer Fatalities)	6.0×10^{-6}	0.0020	0.0016	0.00083	4.0×10^{-6}	0.0020	0.0079	3.5×10^{-6}
Incident-Free Radiological Risk to the Maximally Exposed Individual Worker (Probability of a Latent Cancer Fatality per year)	0.00080	0.00080	0.00080	0.00080	0.00080	0.00080	0.00080	0.00080
Incident-Free Radiological Risk to the Worker Population (Latent Cancer Fatalities)	0.48	0.27	0.25	0.24	0.28	0.27	0.34	0.40
Incident-Free Chemical Risk to an Individual Member of the Public (Probability of a Latent Cancer)	6×10^{-11}	6×10^{-11}	0	0	6×10^{-11}	6×10^{-11}	0	6×10^{-11}
Incident-Free Hazard Index (Individual Member of the Public)	0	5×10^{-9}	4×10^{-9}	3×10^{-9}	0	5×10^{-9}	1×10^{-8}	0
Incident-Free Chemical Risk to the Public Population (Number of Cancers)	<1	<1	<1	<1	<1	<1	<1	<1
Incident-Free Chemical Risk to an Individual Noninvolved Worker (Probability of a Latent Cancer)	3×10^{-9}	3×10^{-9}	0	0	3×10^{-9}	3×10^{-9}	0	3×10^{-9}

Impact	Management Approaches							
	No Action Alternative	*Preferred Alternative*[a]	*Minimize Total Process Duration at Rocky Flats*	*Minimize Cost*	*Conduct all Processes at Rocky Flats*	*Conduct Fewest Actions at Rocky Flats*	*Process with Maximum Plutonium Separation*	*Process without Plutonium Separation*
Incident-Free Hazard Index (Individual Worker)	0	6×10^{-8}	5×10^{-8}	4×10^{-8}	0	6×10^{-8}	1×10^{-7}	0
Incident-Free Chemical Risk to the Noninvolved Worker Population (Number of Cancers)	<1	<1	<1	<1	<1	<1	<1	<1
Accident Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	0.000035	0.000038	0.000032	0.000035	0.000036	0.000038	0.000046	0.000036
Accident Risk to the Public Population (Latent Cancer or Traffic Fatalities)	0.62	0.64	0.53	0.62	0.64	0.64	0.67	0.65
Accident Risk to the Onsite Noninvolved Worker (Probability of a Latent Cancer Fatality)	0.00061	0.00070	0.00062	0.00065	0.00067	0.00070	0.00085	0.00067
Other Impacts								
Intersite Round-Trip Transportation (1,000 km)[f]	0	208	166	84	0	208	823	0
Cost (million $)[g,h]	876[i,j]	524[k]	482[k]	428[k]	510[j]	668[j]	814[l]	539[k]
Processing Duration at Rocky Flats (years)[m]	7.2	5.5[n,o]	2.6[n,p]	3.2[n]	5.1	2.8[n,q]	3.4[n,p]	10.2
Air Quality Impacts	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)
Nuclear Nonproliferation Considerations	See Note *r*	See Note *s*	See Note *s*	See Note *s*	See Note *s*	See Note *s*	See Note *s*	See Note *s*

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Includes secondary waste generated during the processing of residues and scrub alloy such as contaminated gloves and equipment.
[d] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680) kg) of high-level waste glass.
[e] To convert to pounds, multiply by 2.205
[f] To convert thousands of kilometers to thousands of miles, multiply by 0.62.
[g] Decisional costs for labor, site overheads, itemized equipment, residue and waste processing, waste shipment and disposal, and fissile materials disposition, plus non-decisional costs for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work. Excludes adjustments for technical or schedule uncertainties.
[h] Millions of undiscounted 1997 dollars.
[i] Includes $460 million for 20 years of interim storage at Rocky Flats.

[j] Includes $220 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.

[k] Includes $190 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.

[l] Includes $250 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.

[m] Sum of durations for processing technologies with the shortest individual processing time at RF. All processes at different buildings or modules at RF are conducted concurrently. The sum of the shortest processing time at the site since longer duration processing Technologys at one facility may shorten the total duration at the site. Processing duration does not reflect technical or schedule uncertainties, deferred start-up due to technology demonstration and testing, or schedule interactions among processing technologies, facilities, or sites.

[n] Includes processes at SRS F-Canyon. Processing durations at the Savannah River Site depend on schedules for materials in programs outside the scope of this EIS.

[o] Processing duration at LANL is about four months.

[p] Processing duration at LANL is about six months.

[q] Processing duration at Los Alamos National Laboratory depends on the type of new salt distillation equipment and the timing of its installation. The duration therefore depends on schedules for materials in programs outside the scope of this EIS.

[r] The plutonium residues and scrub alloy would be left in forms that cannot be disposed of due to nuclear nonproliferation concsiderations.

[s] The plutonium residues and scrub alloy would be managed and placed in forms that can be disposed of or dispositioned in a manner that supports U.S. nuclear weapons nonproliferation policy.

Table 2–28 Rocky Flats Cumulative Radiological Impacts

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
Waste Generation									
Stabilized Residues (drums)[e]		0	0	21,300	18,400	0	0	21,300	17,600
Transuranic Waste (cubic meters)	1	6,300	400	8,200	500	4,900	11,600	19,400	11,700
Low-Level Waste (cubic meters)	1	41,000	900	12,100	900	96,000	138,000	149,000	138,000
Low-Level Mixed Waste (cubic meters)	1	21,000	0	0	0	192,000	214,000	213,000	401,000
Offsite Population									
Collective dose, 10 years (person-rem)	2	1.6	0.0046	0.024	0.0057	228	230	230	230
Number of latent cancer fatalities from collective dose	3	0.00080	2.3×10^{-6}	0.000012	2.9×10^{-6}	0.11	0.11	0.11	0.11
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	4	0.00047	0.00012	0.00105	0.00019	0.23	0.23	0.23	0.23
Probability of a latent cancer fatality	5	2.3×10^{-10}	6.0×10^{-11}	5.3×10^{-10}	9.5×10^{-11}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}
Worker Population									
Collective dose, 10 years (person-rem)	6	2,630	425	2,040	582	1,723	4,778	6,393	4,935
Number of latent cancer fatalities from collective dose	7	1.1	0.17	0.82	0.23	0.69	2.0	2.6	2.0

[a] Other reasonably foreseeable future actions include special nuclear materials management; deactivation, decontamination, and decommissioning of Rocky Flats facilities; and environmental restoration activities (DOE 1997b).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 1.6-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Standard 208-liter (55-gallon) drums. (208 Liters is equal to 0.208 cubic meters.)

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions from Tables B.5-1, B.5-2, and B.5-3 of DOE 1997c, not counting waste requiring Access Controls Only and/or No further Action.

(2) Assumes all facilities operate concurrently for the same 10-year period. The dose due to existing operations is from Table 11.15-2 of DOE 1997c. The dose due to other reasonably foreseeable future actions is from Table 5.8-5 of DOE 1997b, minus the dose due to existing operations.

(3) Assumes 0.0005 latent cancer fatalities per person-rem.

(4) Based on (DOE 1994c) for existing operations, which contains releases for the year 1992. The dose due to other reasonably foreseeable future actions is from Table 5.8-4 of DOE 1997b.

(5) Assumes 5×10^{-7} latent cancer fatalities per mrem.

(6) Assumes that all facilities operate concurrently for the same 10-year period. The dose due to existing operations is based on the 1996 dose to workers of 263 person-rem (DOE 1997b). The dose due to other reasonably foreseeable future actions is the sum of the doses in Table 5.8-1 of DOE 1997b, minus the dose for residue management.

(7) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 2–29 Cumulative Air Quality Impacts at Rocky Flats

Pollutant	*Baseline Concentration ($\mu g/m^3$)*	*Modeled Concentration ($\mu g/m^3$)*	*Concentration from Other Onsite Sources[a] ($\mu g/m^3$)*	*Total Concentration ($\mu g/m^3$)*	*Averaging Time*	*Most Stringent Regulation or Guideline ($\mu g/m^3$)*
Nitrogen Dioxide	1.4	0.00014	0.0	1.4	Annual	100
Hydrochloric Acid	0.0052	4.2×10^{-7}	0.001	0.0062	Annual	N/A
Carbon Tetrachloride	0.0024	0.000031	0.002	0.0044	Annual	N/A

N/A = not applicable

[a] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Rocky Flats, based on *Rocky Flats Cumulative Impacts Document* (DOE 1997b).

Table 2–30 Savannah River Site Cumulative Radiological Impacts

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
Waste Generation									
High-Level Waste (canisters)[e]	1	4,600	0	43	5	(f)	4,600	4,643	4,605
Transuranic Waste (cubic meters)	2	17,100	0	100	10	65,000	82,100	82,200	82,110
Low-Level Waste (cubic meters)	3	500,000	0	200	42	2,500,000	3,000,000	3,000,000	3,000,000
Low-Level Mixed Waste (cubic meters)	4	13,000	0	0	0	11,000,000	11,000,000	11,000,000	11,000,000
Saltstone (cubic meters)	5	627,000	0	2,500	500	(f)	627,000	630,000	628,000
Offsite Population									
Collective dose, 10 years (person-rem)	6	68	0	0.38	0.062	686	754	754	754
Number of latent cancer fatalities from collective dose	7	0.034	0	0.00019	0.000031	0.34	0.37	0.37	0.37
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	8	0.14	0	0.0034	0.00057	9.8	9.9	9.9	9.9
Probability of a latent cancer fatality	9	7.0×10^{-8}	0	1.7×10^{-9}	2.9×10^{-10}	4.9×10^{-6}	5.0×10^{-6}	5.0×10^{-6}	5.0×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	6	8,400	0	469	76	8,309	16,700	17,200	16,800
Number of latent cancer fatalities from collective dose	10	3.4	0	0.19	0.030	3.3	6.7	6.9	6.7

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to defense waste processing (DOE 1994d); tritium supply and recycle (DOE 1995c); spent nuclear fuel management, including spent nuclear fuel from foreign research reactors (DOE 1995d); other site-specific waste management actions, including environmental restoration activities (DOE 1995e); F-Canyon (DOE 1994d); interim management of nuclear materials (DOE 1995f); storage and disposition of weapons-usable fissile materials (DOE 1996a); stockpile stewardship and management (DOE 1996g); transfer of nonnuclear functions (DOE 1993); and disposition of highly enriched uranium (DOE 1996i).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.17-2 of the Waste Management Programmatic EIS (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.

[f] The waste generation due to other reasonably foreseeable future actions (20 years) is included in the column of waste generation due to existing operations.

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c.
(2) Data for existing operations from Tables 1.6-2 and B.5-3 of DOE 1997c.
(3) Data for existing operations from Tables 1.6-2 and B.5-1 of DOE 1997c.
(4) Data for existing operations from Tables 1.6-2 and B.5-2 of DOE 1997c.
(5) Data for existing operations from Table 5-5 of DOE 1994d.
(6) Assumes all facilities operate concurrently for the same 10-year period.
(7) Assumes 0.0005 latent cancer fatalities per person-rem.
(8) Based on (DOE 1994c) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing residues and scrub alloy are received in 1 year.
(9) Assumes 5×10^{-7} latent cancer fatalities per mrem.
(10) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 2–31 Cumulative Air Quality Impacts at the Savannah River Site

Pollutant	*Baseline Concentration ($\mu g/m^3$)*	*Modeled Concentration ($\mu g/m^3$)*	*Concentration from Other Onsite Sources*[b]	*Total Concentration ($\mu g/m^3$)*	*Averaging Time*	*Most Stringent Regulation or Guideline ($\mu g/m^3$)*[a]
Nitrogen Dioxide	8.8	0.039	3.6	12.4	Annual	100
Nitric Acid	50.96	0.65	4.76	56.37	24-hour	125
Hydrogen Fluoride	0.09 0.39 1.04 1.99	0.00036 0.0032 0.0032 0.0051	0.019 0.067 0.175 0.327	0.11 0.46 1.22 2.32	30-day 7-day 24-hour 12-hour	0.8 1.6 2.9 3.7
Phosphoric Acid	0.462	0.0016	0.0	0.464	24-hour	25

[a] Federal and State standards.

[b] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Savannah River based on the *Storage and Disposition of Weapons - Usable Fissile Materials Final PEIS* (DOE 1996a).

Table 2–32 Los Alamos National Laboratory Cumulative Radiological Impacts

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
Waste Generation									
Transuranic Waste (cubic meters)	1	10,800	0	600	200	4,400	15,200	15,800	15,400
Low-Level Waste (cubic meters)	2	150,000	0	1,300	400	325,000	475,000	476,000	475,000
Low-Level Mixed Waste (cubic meters)	3	2,770	0	0	0	980	3,750	3,750	3,750
Offsite Population									
Collective dose, 10 years (person-rem)	4	16	0	0.0024	0.00079	16.9	33	33	33
Number of latent cancer fatalities from collective dose	5	0.0079	0	1.2×10^{-6}	4.0×10^{-7}	0.0085	0.016	0.016	0.016
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	6	7.9	0	0.00080	0.00027	0.37	8.3	8.3	8.3
Probability of a latent cancer fatality	7	4.0×10^{-6}	0	4.0×10^{-10}	1.4×10^{-10}	1.9×10^{-7}	4.2×10^{-6}	4.2×10^{-6}	4.2×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	4	4,580	0	160	8.8	763	5,340	5,340	5,350
Number of latent cancer fatalities from collective dose	8	1.8	0	0.064	0.0035	0.31	2.1	2.2	2.1

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to dual-axis radiographic hydrodynamic test facility (DOE 1995g), medical isotope production (DOE 1996l), transfer of nonnuclear functions (DOE 1993) and stockpile stewardship and management (DOE 1996g).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats pyrochemical salts, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.9-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats pyrochemical salts.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats pyrochemical salts.

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-3 of DOE 1997c.

(2) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-1 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.

(3) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-2 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.

(4) Assumes all facilities operate concurrently for the same 10-year period.

(5) Assumes 0.0005 latent cancer fatalities per person-rem.

(6) Based on (DOE 1994c) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing Rocky Flats pyrochemical salts are received in 1 year.

(7) Assumes 5×10^{-7} latent cancer fatalities per mrem.

(8) Assumes 0.0004 latent cancer fatalities per person-rem.

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3. THE AFFECTED ENVIRONMENT

The affected environment descriptions in this chapter provide the background for understanding the environmental consequences described in Chapter 4 and serve as a baseline from which to identify and evaluate any environmental changes that may result from implementation of the proposed actions and alternatives. The resources that may be affected by the proposed action are grouped into the following interest areas for analysis in this environmental impact statement (EIS):

- Site infrastructure
- Air quality
- Socioeconomics
- Public and occupational health and safety
- Waste management

As discussed in Chapter 4, Section 4.1.1, impacts on the following resource areas are not expected to occur and, so, were not evaluated quantitatively: land and water, noise, geology and soils, ecological and cultural and paleontological. The potential impacts of the proposed action involve consideration only of the existing conditions for site infrastructure, air quality, socioeconomics, public and occupational health and safety, and waste management; therefore, only these resource areas are described in detail in this chapter. Pertinent summary information and references to sources providing additional information are provided for the other resource areas, however.

The following paragraphs describe the resource areas potentially impacted by the actions assessed in this EIS. Sections 3.1 through 3.3 present information on the resources that exist at each of the sites being evaluated.

❒ **Site Infrastructure—**Site infrastructure includes those utilities and other resources required to support construction and continued operation of mission-related facilities identified under the various alternative actions. The resources described and analyzed in this EIS include electrical power and electrical load capacity requirements; natural gas, coal, and oil fuel requirements; and transportation networks, including roads and rail interfaces.

❒ **Air Quality**

- *Meteorology and Climatology*—Meteorology and climatology combine to provide an overall description of regional temperature, precipitation, and wind direction and speed, as well as an overall characterization of the regional climate (e.g., mild winters and long, humid summers).

- *Air Quality*—Air quality is affected by air pollutant emission characteristics, meteorology, and topography. Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures, or that unreasonably interferes with the comfortable enjoyment of life and property. For the purpose of this EIS, only outdoor air pollutants are addressed. Pollutants may include almost any natural or artificial compound capable of being airborne and may be in the form of solid particles, liquid droplets, gases, or combinations of these forms. Generally, pollutants can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants, or by reaction with normal

atmospheric constituents, with or without photoactivation). Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions.

Ambient air quality in a given location can be characterized by comparing the concentration of various pollutants in the atmosphere to their corresponding standards. Ambient air quality standards have been established by Federal and State agencies, allowing an adequate margin of safety for protection of public health and welfare from adverse effects associated with pollutants in the ambient air. Pollutant concentrations higher than the corresponding standards are considered unhealthy. Maintaining concentrations below the corresponding standards would protect most members of the public from adverse health effects.

The primary pollutants of concern are those for which Federal and State ambient air quality standards have been established, including criteria pollutants, hazardous air pollutants, and other toxic air pollutants. Criteria pollutants are those defined in Title 40 of the Code of Federal Regulations (CFR) Part 50, "National Primary and Secondary Ambient Air Quality Standards." Hazardous air pollutants and other toxic compounds include those listed in Title III of the 1990 Clean Air Act, and those that have been proposed or adopted in regulations or are listed in guidelines by the respective states.

- **Socioeconomics—**Socioeconomics comprises the social, economic, and demographic characteristics of an area. The socioeconomic environment can be affected by changes in employment, income, and population, which, in turn, can affect area resources such as housing, community services, and infrastructure.

  The socioeconomic analysis assesses the environmental consequences of demographic and economic changes resulting from proposed alternatives, especially the potential impacts of additional workers and their families on the economy, housing availability, community services, and infrastructure.

- **Public and Occupational Health and Safety—**Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from exposure to ionizing radiation and hazardous chemicals. The degree of hazard is directly related to the type and quantity of the particular radioactive or chemical material to which the person is exposed and to the duration of the exposure.

  The current radiological and chemical environments at the various sites considered in this EIS help characterize the setting and serve as baselines against which impacts associated with the various program actions can be compared. Of particular importance are the radiological and hazardous chemical doses that workers and the public receive from exposures associated with both the natural background and existing site operations. These doses may result in adverse health effects.

- **Waste Management—**Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing U.S. Department of Energy (DOE) activities. Waste management covers waste produced by DOE's processing, manufacturing, remediation, decontamination and decommissioning, and research activities. The waste is managed using appropriate treatment, storage, and disposal technologies in compliance with all applicable Federal and State statutes and DOE Orders. Wastes are generated and categorized by their health hazard and handling requirements. Treated waste is waste that, following generation, has been altered chemically or physically to reduce its toxicity or to prepare it for storage or disposal. Waste treatment can include volume reduction activities, such as incineration or compaction, which may be performed on waste before either storage, disposal, or both. Stored waste is waste that, following generation (and usually some treatment), is being retained (temporarily) in a retrievable manner and monitored pending disposal. Disposed waste is waste that has been put in final emplacement to ensure its isolation from the environment with no intention of retrieval.

Deliberate action would be required to regain access to the waste. Disposed wastes include materials placed in a geological repository or buried in landfills.

3.1 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Rocky Flats Environmental Technology Site (Rocky Flats) is located in rural northern Jefferson County, Colorado, 26 kilometers (km) (16 miles [mi]) northwest of downtown Denver and approximately 19 km (12 mi) south of Boulder. Once a remote site, Rocky Flats is now next to a large and growing metropolitan area that includes the communities of Boulder, Arvada, Westminster, Broomfield, and Golden. The Rocky Flats Industrial Area occupies approximately 155 hectares (ha) (384 acres [ac]) in the middle of the site. The remaining 2,495 ha (6,165 ac) form a buffer zone around the active part of Rocky Flats and provide more than 1.6 km (1 mi) between the developed portion of the site and any public road or private property. DOE property boundaries for the site are shown in **Figure 3–1**.

Rocky Flats' mission is to perform environmental restoration, cleanup, and waste management. The locations of major plutonium facilities at Rocky Flats are shown in **Figure 3–2**. Current activities at Rocky Flats are all related to DOE activities. Rocky Flats missions are listed in **Table 3–1**.

Table 3–1 Current Missions at Rocky Flats

Mission	*Description*
Interim Plutonium Storage	Maintain Buildings 371, 559, 707, 771, and 776/777 for interim plutonium storage, with eventual consolidation into a single facility.
Rocky Flats Environmental Restoration and Waste Management	As buildings are released from storage and stabilization missions, decontaminate and decommission, remove all plutonium and other toxic and/or hazardous materials and prepare plutonium wastes for final transport to long-term storage facility.

Source: DOE 1996a.

❒ **DOE Activities—**The site will continue its plutonium storage function, using existing buildings for nonsurplus and surplus plutonium materials. Plutonium component fabrication and production support activities have been stopped permanently; any future activities would take place at other DOE sites.

The current Rocky Flats long-term mission is to prepare plutonium processing and fabrication facilities for decontamination and decommissioning with final disposition by DOE's Office of Environmental Management. The plutonium storage mission involves materials designated as either strategic reserve for current or anticipated program needs, surplus that can be converted to stable metal or oxide forms for storage and transport, or residue that is destined for disposal as waste. Plutonium storage capabilities would be maintained in Buildings 371, 559, 707, 771, and 776/777, with eventual consolidation into a single facility.

The previous primary mission of Rocky Flats was to produce components for nuclear weapons from such materials as plutonium, uranium, beryllium, and various alloys of stainless steel. Production was stopped in 1989. Until that time, the details of plant operations were classified, with little mission and management information given to the public. The site was off-limits to the general public. In 1992, the plant's production of nuclear weapon components was officially discontinued with the end of the Cold War.

Rocky Flats now has a new mission—focusing on environmental restoration, waste management, management of special nuclear materials onsite (including plutonium), decontamination and decommissioning of facilities, and economic development. Although the site remains off-limits to the general public for health and safety considerations, DOE provides information to the public concerning management and operations and works closely with the public on issues related to Rocky Flats.

❒ **Non-DOE Activities—**None.

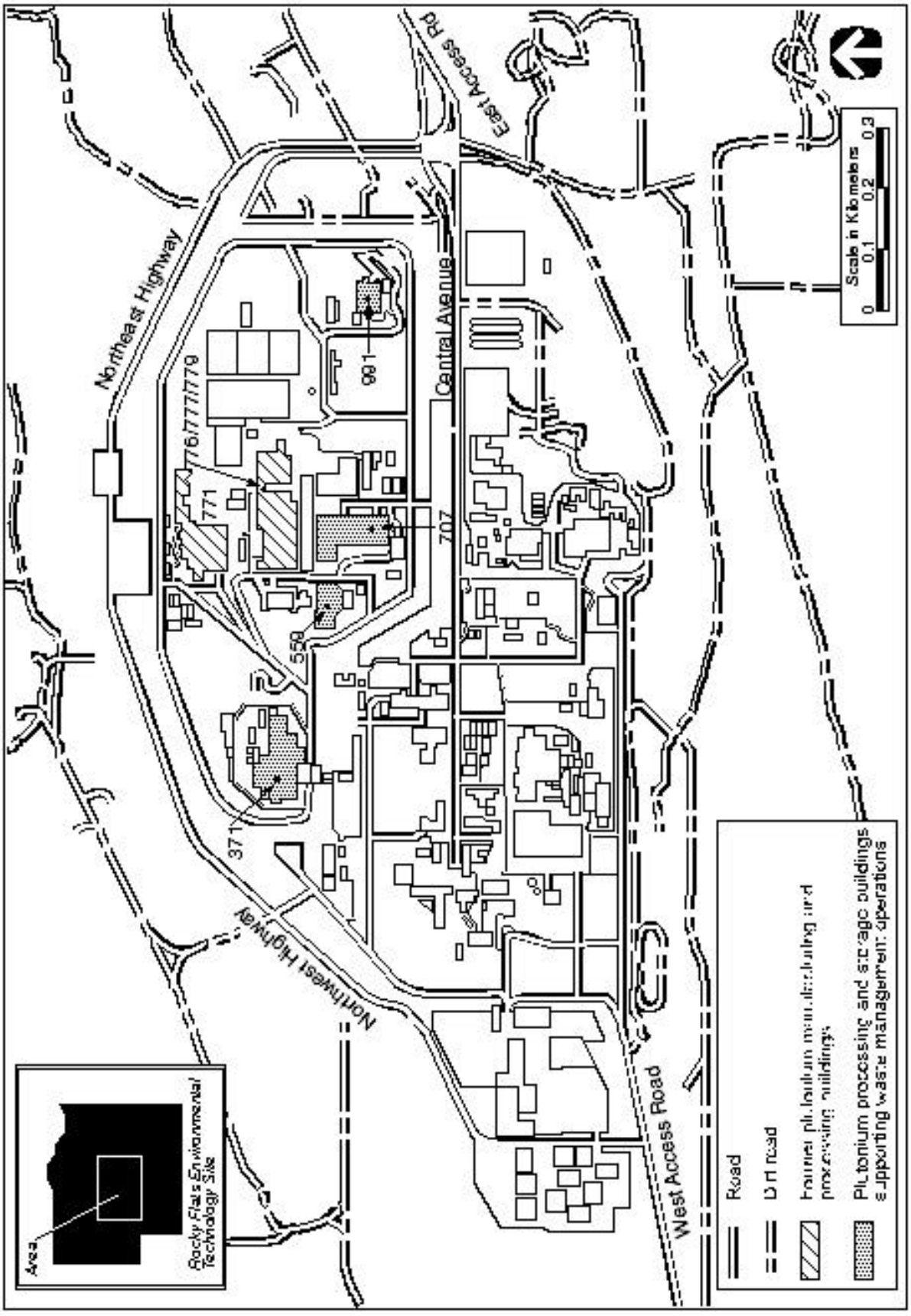


Figure 3–1 Site Designations, Principal Facilities, and Testing Areas at Rocky Flats

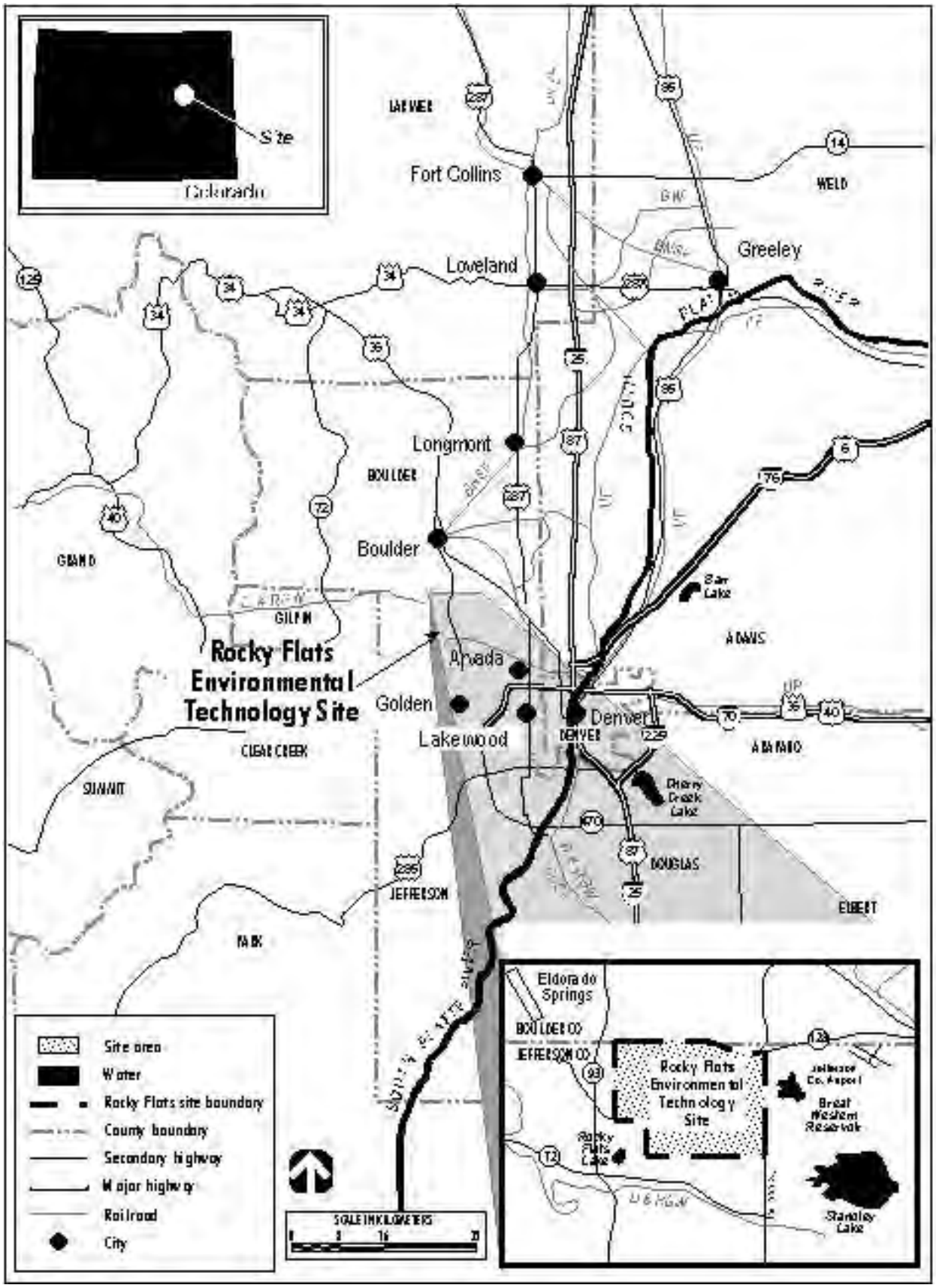


Figure 3–2 Rocky Flats, Colorado, and Region

3.1.1 Land Resources

❒ **Land Use—**The 2,530-ha (6,260-ac) Rocky Flats Site is located in northern Jefferson County, Colorado, approximately 26 km (16 mi) northwest of downtown Denver. All land within Rocky Flats is owned by the Federal Government and managed and controlled by DOE.

Generalized land uses within Rocky Flats and the immediate vicinity are illustrated in **Figure 3–3**. Rocky Flats contains two major categories of land use: industrial and undeveloped. Former production facilities occupy approximately 155 ha (384 ac), or 6 percent of the site, and are centrally located on the site. The approximately 2,380 ha (5,880 ac) that remain are used as a security buffer zone and are mostly open space (undeveloped). However, there are several other uses, including approximately 8 ha (20 ac) of former production support facilities, approximately 45 ha (111 ac) of sanitary waste disposal, and 211 ha (523 ac) of aggregate and clay mining. No prime farmland exists onsite. There are no public recreation facilities onsite. Land uses surrounding the site include primarily open space, industrial, and rural residential and agricultural (grazing and hay production) (DOE 1993a).

Land use planning does not occur at the State level within Colorado; however, regional planning within the Rocky Flats vicinity occurs through the advisory Denver Regional Council of Governments. Rocky Flats is located within Jefferson County, one of six counties that comprise the Denver Regional Council of Governments. Jefferson County does not currently have a countywide comprehensive plan; however, the county has adopted community plans. Community plans function as land-use plans for specific areas of the county; their recommendations are used for making and granting future land-use decisions. The North Plains Community Plan designates Rocky Flats as a "Special Use Area" (JCPD 1990). The zoning resolution for Jefferson County classifies Rocky Flats land with the following zoning districts: agricultural, industrial, and special use.

❒ **Visual Resources—**The terrain of Rocky Flats is mostly grazing land with low hills and ridges. Construction and operation of DOE's facilities have heavily disturbed the character of the landscape. The most dominant features of the site include two large stacks and a water tank. Existing facilities are separated from public roads by the open land in the buffer area. The Rocky Mountains start to rise approximately 3.2 km (2 mi) to the west of Rocky Flats. Because access to the site is limited to authorized personnel, public visual access is limited to views from the outside (DOE 1993a). The facilities are brightly lit at night and are highly visible from many areas within a 4.8- to 8-km (3- to 5-mi) radius of the site. The area within the central developed area is consistent with the Bureau of Land Management's designation of Visual Resource Management Class 5. Class 5 designates areas in which cultural activities are dominant features of the landscape. For the remainder of the site, the natural landscape dominates or natural features are discernible.

3.1.2 Site Infrastructure

❒ **Baseline Characteristics—**Activities at Rocky Flats are concentrated in facilities located near the middle of the site. Baseline site infrastructure characteristics are shown in **Table 3–2**.

Two-lane county and State highways pass around the site, including State Highway 93 to the west, State Route 128 to the north, and Indiana Street to the east. No roads exist along the southern boundary of the site and no public access roads extend across Rocky Flats. Rocky Flats has controlled access gates to the east and west; a controlled access paved road runs through the middle of the site, connecting Highway 93 to Indiana Street. The site also has numerous dirt firebreak and access roads for management. Nuclear

wastes from Rocky Flats are transported by truck primarily along the interstate highway system. Nuclear shipments are restricted to off-peak periods when traffic activity is low.

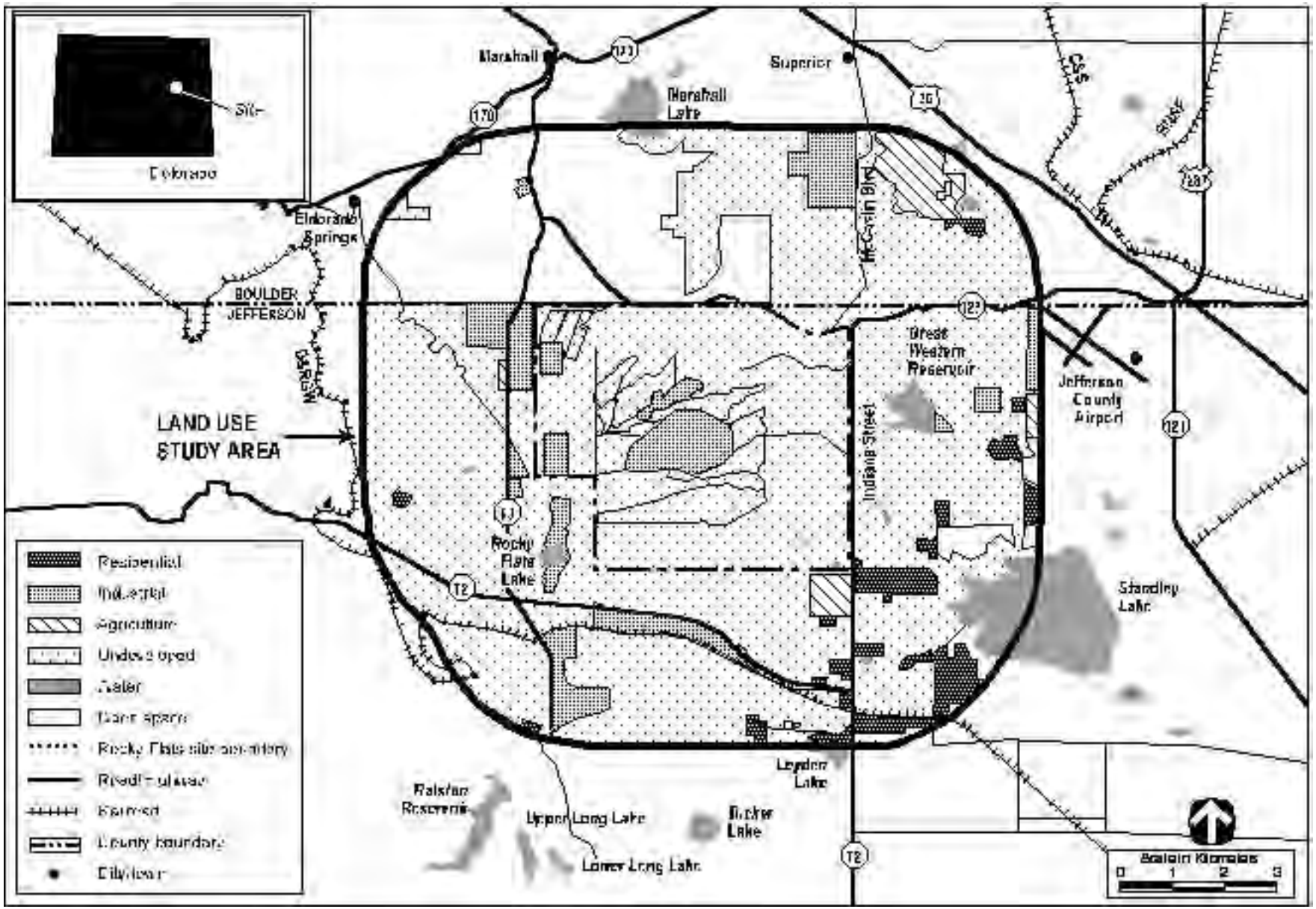


Figure 3–3 Generalized Land Use at Rocky Flats and Vicinity

Table 3–2 Rocky Flats Baseline Characteristics

Characteristics	*Current Usage*
Transportation	
Roads (km)	40
Railroads (km)	5
Electrical	
Energy consumption (MWh/yr)	184,000
Peak Load (MWe)	26
Fuel	
Natural gas (m^3/yr)	18,600,000
Oil (L/yr)	8,140,000
Coal (t/yr)	0
Steam (kg/hr)	41,000

km = kilometer MWh/yr = megawatt hours per year MWe = megawatts electric m^3/yr = cubic meters per year
L/yr = liters per year t/yr = tons per year kg/hr = kilograms per hour
Source: Adapted from DOE 1996a.

Normal and alternate power is supplied by the Public Service Company of Colorado through two electrical switching stations. Currently, one station (to the north of the site) supplies primary services, and the other (just outside the west gate) supplies service to a small portion of the western side of the site and serves as backup electrical power. Emergency diesel generators provide additional backup power capabilities. The subregional electric power pool from which Rocky Flats draws its power is the Rocky Mountain Power Area. Capabilities of this power pool are summarized in **Table 3–3**.

Table 3–3 Rocky Mountain Area Subregional Power Pool Electrical Summary

Characteristics	*Energy Production*
Type Fuel	
Coal	71 percent
Nuclear	0 percent
Hydro/Geothermal	15 percent
Oil/Gas	5 percent
Other (includes power from both utility and nonutility sources)	9 percent

Source: NERC 1993.

The site is connected to a Public Service Company natural gas line. The line passes through the site and continues west to serve residential customers in the Coal Creek Canyon area.

The site acquires water by either of two methods; the method used at any particular time is at the discretion of the Denver Water Board. The preferred supply comes from a diversionary canal between Gross and Ralston Reservoirs. The canal passes the site between the west gate and Route 93 and provides gravity-fed flow to a holding pond, also to the west of the site. The second method involves pumping water directly from Ralston Reservoir to the holding pond, overcoming more than 300 feet of head pressure.

The locations of buildings at Rocky Flats were shown earlier in Figure 3–1. Descriptions of pertinent buildings follow.

- **Building 371—**Building 371 currently stores Category I and II special nuclear material and will be the primary special nuclear material consolidation and interim storage facility until long-term storage and disposition actions are decided and implemented. Currently, some of Rocky Flats' plutonium residues, transuranic waste, and Resource Conservation and Recovery Act waste inventories are stored in Building 371. The 4-level facility has approximately 17,300 m^2 (186,000 ft^2) of floor space and contains 6 plutonium storage vaults and vault-type rooms. A stacker/retriever moves radioactive materials between the central storage vault and the input and output stations. In addition to this transport capability, the central storage vault was designed for storage of Category I and II special nuclear material. Building 371 was built to nuclear design standards; other buildings at the site were constructed to industrial standards.

- **Building 707—**Building 707 formerly was the location for plutonium foundry, machining, and assembly operations related to plutonium weapons components. Currently, small amounts of residue and waste inventories and the majority of plutonium metal at the site are stored in this building. The facility is a two-story building with a single-story section on the east side. The 2-story section has 6,900 m^2 (74,240 ft^2) per floor and the single-story section has 1,724 m^2 (18,560 ft^2). There is a small basement with an area of 93 m^2 (1,000 ft^2). The annex, Building 707A, is a 2-story, freestanding structure with 1,210 m^2 (13,000 ft^2) per floor. The main floor of the building is compartmentalized into eight modules (Modules A through H). There are two additional modules within the annex, Modules J and K. Several of the modules in both the main building and the annex are proposed for processing of the plutonium residues. The main facility has a remote-handled plutonium storage vault.

3.1.3 Air Quality and Noise

- **Meteorology and Climatology—**The Rocky Flats region is characterized as a dry climate, middle-latitude steppe, with mild, sunny, semiarid conditions and few temperature extremes. The average annual temperature at Rocky Flats is 10.2°C (50.3°F); temperatures vary from an average daily minimum of -8.8°C (16.1°F) in January to an average daily maximum of 31.2°C (88.2°F) in July. The average annual precipitation at Rocky Flats is 39.1 centimeters (15.4 inches) (DOE 1994a).

  Annual mean windspeeds and wind direction frequencies for Rocky Flats for 1990 are presented in **Figure 3–4**. Data are from the meterological tower on the west buffer zone. The wind rose shows that the predominant wind direction frequency is toward the west-northwest with a secondary maximum toward the west. The mean windspeed toward the west-northwest is 6.3 m/s (14.1 mph) and the maximum mean windspeed toward the west is 5.7 m/s (12.8 mph) (NOAA 1994). Storms in the Rocky Flats area can generate winds with speeds as high as 44.6 m/s (100 mph) (Kaiser-Hill 1994). Meteorological monitoring station data collected at Rocky Flats indicate that unstable conditions occurred about 59 percent of the time in 1990, neutral conditions occurred about 26 percent, and stable conditions occurred about 15 percent of the time (DOE 1996a).

  The historical data for Denver indicated that the average annual windspeed is 3.8 m/s (8.6 mph) (DOE 1996a). The fastest 1-minute windspeed recorded in Denver, Colorado, was 20.6 m/s (46 mph) (NOAA 1994).

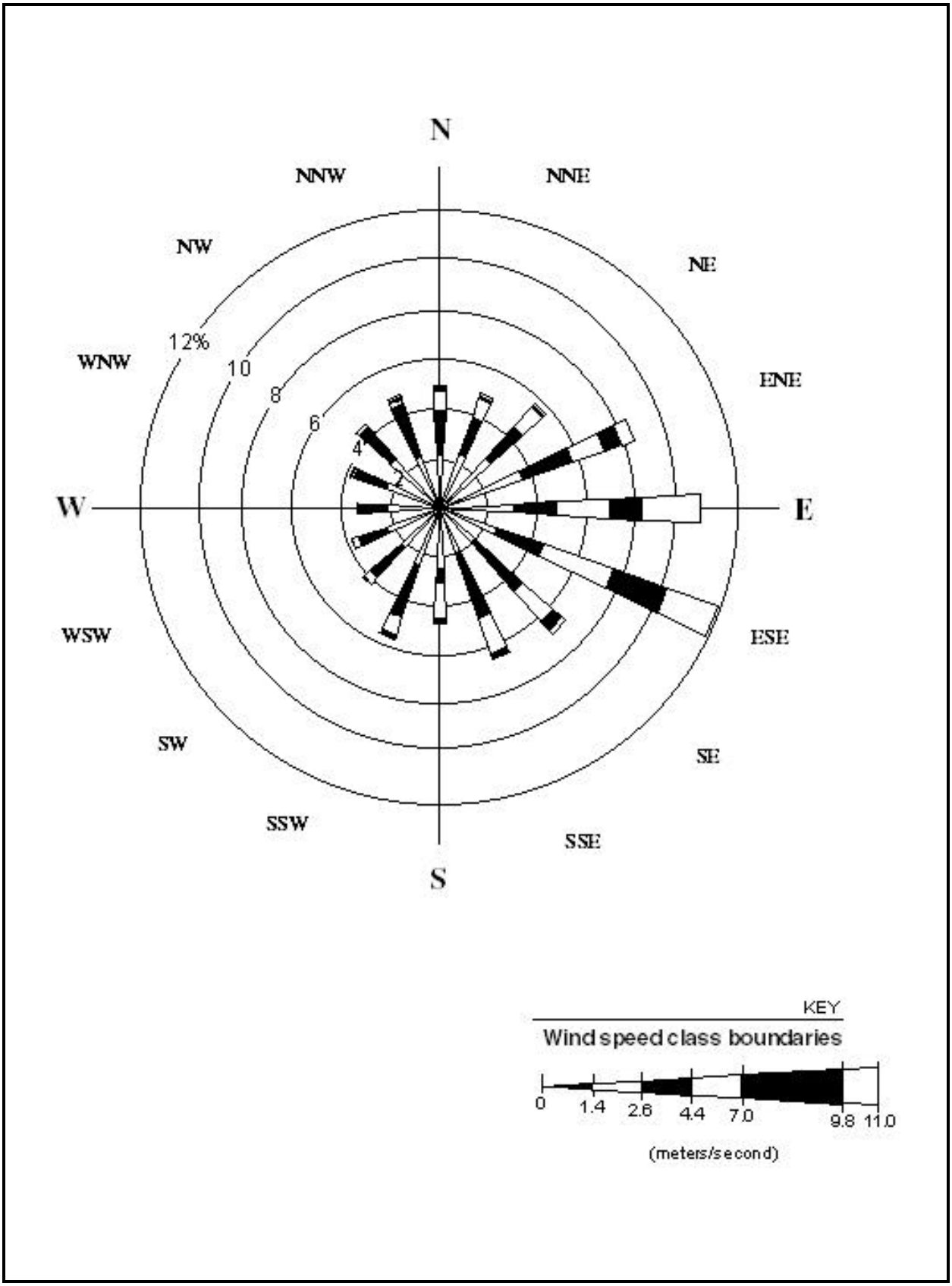


Figure 3–4 Wind Rose for the Rocky Flats Environmental Technology Site (1991-1994) (61-meter level)

❒ **Air Quality—**Rocky Flats is located within the Metropolitan Denver Intrastate Air Quality Control Region No. 36. This Air Quality Control Region is designated nonattainment with respect to the National Ambient Air Quality Standards for particulate matter (≤10 microns in diameter) (moderate), ozone (transitional), and carbon monoxide (serious) and is listed as attainment for sulfur dioxide and nitrogen dioxide (Title 40 CFR 81.306). The particulate matter (≤10 microns in diameter) (PM_{10}) standard is exceeded primarily because of fugitive dust. Vehicular traffic is a major contributor to the high concentrations of ozone and carbon monoxide in the region (DOE 1996a). Recent monitoring data has shown no violations of the ambient air quality standards for PM_{10}, ozone, and carbon monoxide and the region is in the process of being redesignated into attainment.

For locations that are in an attainment area for criteria air pollutants, Prevention of Significant Deterioration regulations limit pollutant emissions from new sources and establish allowable increments of pollutant concentrations. Allowable Prevention of Significant Deterioration increments currently exist for three pollutants (NO_2, SO_2, and PM_{10}). Three Prevention of Significant Deterioration classifications are designated based on criteria established in the Clean Air Act amendments. Class I areas include national wilderness areas, memorial parks larger than 2,020 ha (5,000 acres), and national parks larger than 2,430 ha (6,000 acres). Class II areas include all areas not designated as Class I. No Class III areas have been designated.

Since the creation of the Prevention of Significant Deterioration program in 1977, Prevention of Significant Deterioration permits have not been required for any new Rocky Flats emission sources. Several Prevention of Significant Deterioration (40 CFR 52.21) Class I areas exist near Rocky Flats. The closest, Rocky Mountain National Park, is located approximately 46 km (30 mi) northwest of Rocky Flats.

The emissions inventory from existing sources at Rocky Flats is shown in **Table 3–4**. The emissions inventory is based on maximum permitted or reported emission rates for 1994. Historically, the principal sources of criteria pollutants at Rocky Flats are the steam plant boilers. Minor combustion sources include various small boilers and diesel generators. Other sources of criteria pollutants included coating operations and particulate matter from various manufacturing operations.

Table 3–4 Emission Rates of Criteria and Toxic/Hazardous Air Pollutants at Rocky Flats Environmental Technology Site

Pollutant	*Annual Emission Rate (kg/yr)*	*Hourly Emission Rate (gm/sec)*
Criteria Pollutants		
CO	37,200	24.1
NO_2	156,000	108
PM_{10}	11,300	12.3
SO_2	10,200	67.0
Lead	1.54×10^{-9}	2.14×10^{-13}
Other Regulated Pollutants[a]		
Hydrogen Sulfide	962	0.0328
Total Suspended Particulates	12,000	13.4
Toxic/Hazardous Pollutants		
Carbon Tetrachloride	163	0.0113
Hydrochloric Acid	245	0.0214

[a] Only toxic pollutants emitted from the alternatives being evaluated are presented. The Draft EIS listed additional toxic pollutants which would not be emitted from any of the proposed alternatives and so are not necessary to assess baseline or cumulative air quality impacts.

Source: Adapted from DOE 1997b.

The State of Colorado Department of Public Health and Environment has not adopted State hazardous and toxic air pollutant standards. **Table 3–5** presents the existing (baseline) air concentrations attributable to Rocky Flats for criteria pollutants and other pollutants of concern at Rocky Flats. These concentrations are based on modeling performed with the maximum emission rates listed in Table 3-4, except for total suspended particulates and PM_{10}, which are based on data from monitors located along the eastern boundary of the Rocky Flats site and operated by the Colorado Department of Public Health and the Environment. The monitored concentrations are expected to be conservative estimates of Rocky Flats impacts because they also include impacts from other nearby industrial sources. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Ambient background concentrations were estimated from Colorado Department of Public Health and Environment monitoring data from 1992-1994, plus modeled impacts of other industrial sources located in the vicinity of Rocky Flats. Ambient background carbon monoxide 8-hour and 1-hour concentrations were estimated as 3,997.2 $\mu g/m^3$ and 13,713.8 $\mu g/m^3$ respectively. Annual ambient background concentrations of nitrogen dioxide are estimated as 19.7 $\mu g/m^3$. Ambient annual, 24-hour and 3-hour sulfur dioxide concentrations are estimated as 10.7 $\mu g/m^3$, 46.1 $\mu g/m^3$, and 178.5 $\mu g/m^3$, respectively. Annual background concentrations of carbon tetrachloride (based on modeling of nearby sources) are estimated at 0.0078 $\mu g/m^3$. One-hour hydrogen sulfide background concentrations are estimated at 0.0025 $\mu g/m^3$. Annual hydrochloric acid background concentrations are estimated at 0.0022 $\mu g/m^3$. These concentrations are also based on modeling of nearby sources. No ambient background values were available for lead (DOE 1997b).

- **Noise—**Major noise sources at Rocky Flats include various facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). No sound-level measurements have been made at Rocky Flats to determine background sound levels. Most Rocky Flats industrial facilities are far enough from the site boundary that their noise is barely distinguishable from background noise.

The acoustic environment along the Rocky Flats boundary and at nearby residences away from traffic noise is typical of a rural location or quiet suburban residential area, with day-night average sound levels in the range of 35 to 52 decibels A-weighted (EPA 1974). Traffic is the primary source of noise at the site boundary and at nearby residences. Rocky Flats onsite traffic contributes little to overall traffic noise; however, traffic noise from other sources is expected to dominate sound levels along major roads in the area. Except for the prohibition of nuisance noise, neither the State of Colorado nor its local governments have established environmental noise standards applicable to Rocky Flats.

3.1.4 Water Resources

- **Surface Water—**The main surface water features at Rocky Flats are Walnut Creek, North Walnut Creek, South Walnut Creek, and Woman Creek (**Figure 3–5**). Streams at Rocky Flats are considered part of the Big Dry Creek drainage basin, although Big Dry Creek is not directly affected by Rocky Flats activities.

Rocky Flats lies on the divide between the Walnut Creek and Woman Creek drainage basins. North Walnut Creek and South Walnut Creek drain the central and northern areas of Rocky Flats, and Woman Creek drains the southern areas. South and North Walnut Creeks flow together and form Walnut Creek, which flows downstream from Rocky Flats and empties into the Broomfield Diversion Ditch. The Broomfield Diversion Ditch routes water around the Great Western Reservoir, which is a public water supply, then into Big Dry

Creek, and eventually into the South Platte River. Woman Creek flows east across the southern portion of Rocky Flats into Woman Creek Reservoir, which was constructed by DOE to intercept flows from Woman Creek to keep the flows from Standley Lake.

Table 3–5 Comparison of the Rocky Flats Contribution to Baseline Air Pollutant Concentrations with Most Stringent Applicable Regulations and Guidelines at Rocky Flats, 1994

Pollutant	*Averaging Time*	*Most Stringent Regulations or Guidelines[a] (µg/m³)*	*Modeled Concentration[b] (µg/m³)*
Criteria Pollutants			
CO	8-hour	10,000[c]	304
	1-hour	40,000[c]	1,160
NO_2	Annual	100[c]	1.4
Ozone	8-hour	157[c, e]	e
	1-hour	160[d, e]	e
PM_{10}[f]	Annual	50[c]	14.0
	24-hour	150[c]	32.0
$PM_{2.5}$[f]	Annual	15	f
	24-hour	65	f
SO_2	Annual	80[c]	0.1
	24-hour	365[c]	91.2
	3-hour	700[d]	270
Lead	Calendar Quarter	1.5[c]	4.8×10^{-14}
	30-day	1.5[c]	4.8×10^{-14}
Other Regulated Pollutants			
Hydrogen Sulfide	1-hour	142[d]	35.4
Total Suspended Particulates	Annual	75[d]	31.0
	24-hour	150[d]	73.0
Toxic/Hazardous Pollutants[h]			
Carbon Tetrachloride	Annual	g	0.0024
Hydrochloric Acid	Annual	g	0.0052

[a] The more stringent of the Federal and State standards is presented.

[b] Modeled concentration based on maximum emissions, except for TSP and PM_{10} concentrations, which are based on data from monitors located at the eastern boundary of the site.

[c] Federal standard.

[d] State standard.

[e] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. EPA recently revised the ambient air quality standards for ozone. The new standards, finalized on July 18, 1997, change the ozone primary and secondary standards from a 1-hour concentration of 235 µg/m³ (0.12 ppm) to an 8-hour concentration of 157 µg/m³ (0.08 ppm). During a transition period, the 1-hour ozone standard would continue to apply in nonattainment areas such as the area in which Rocky Flats is located.

[f] EPA recently revised the ambient air quality standards for particulate matter. The current PM_{10} (particulate matter size less than or equal to 10 micrometers) annual standard is retained and two $PM_{2.5}$ (particulate matter size less than or equal to 2.5 micrometers) standards are added. These standards are set at 15 µg/m³ (3-year average arithmetic mean based on community-oriented monitors) and 65 µg/m³ (3-year average of the 98th percentile of 24-hour concentrations at population-oriented monitors). The current 24-hour PM_{10} standard is revised to be based on the 99th percentile of 24-hour concentrations. Insufficient emissions, modeling, and monitoring data exist for estimating concentrations of $PM_{2.5}$.

[g] No State or Federal standards exist.

[h] Only toxic pollutants emitted from the alternatives being evaluated are presented. The Draft EIS listed additional toxic pollutants which would not be emitted from any of the proposed alternatives and so are not necessary to assess baseline or cumulative air quality impacts.

Source: Adapted from DOE 1997b.

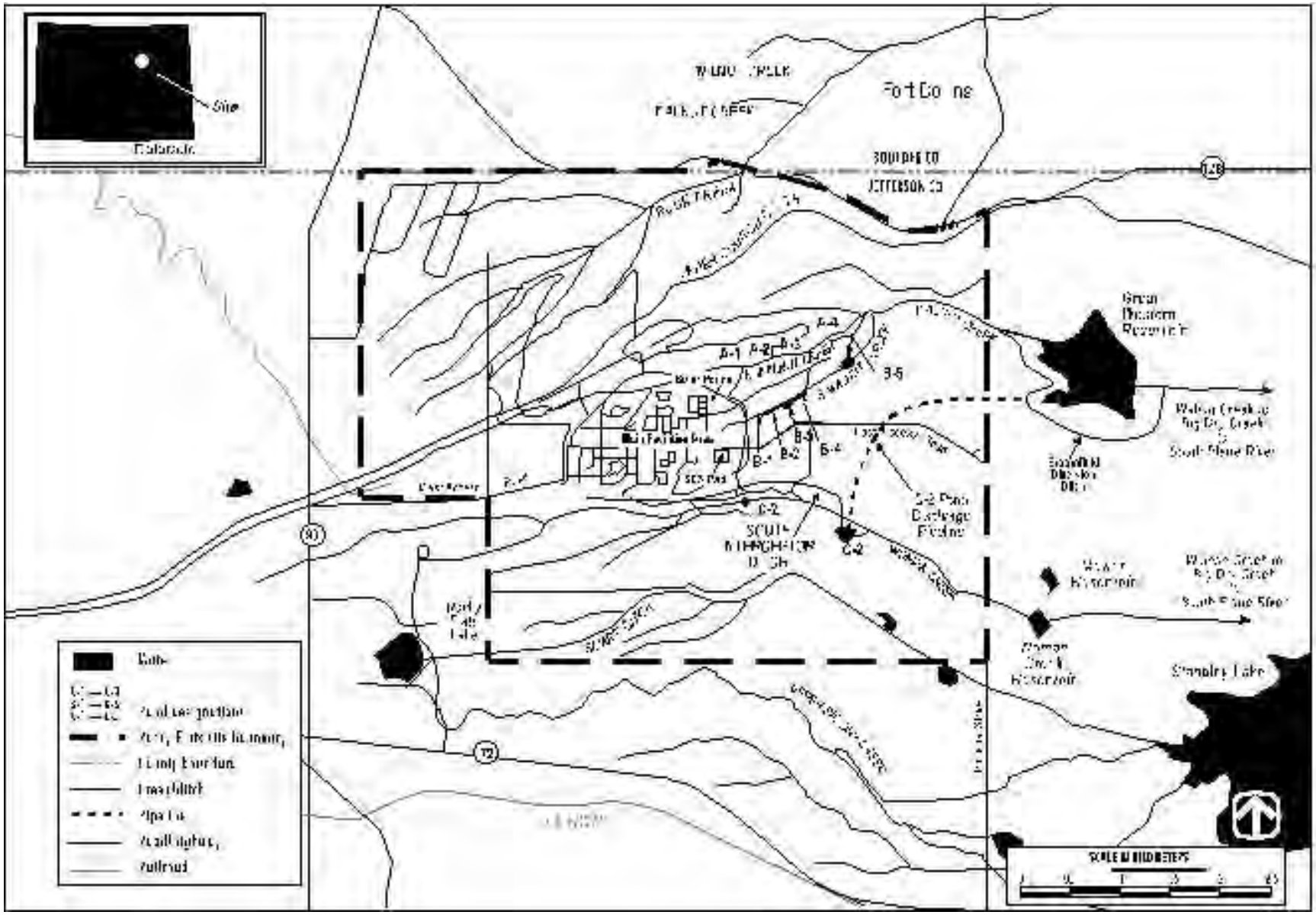


Figure 3–5 Surface Water Features at Rocky Flats

All natural surface water flow on Rocky Flats occurs in temporary channels that flow only as a result of precipitation, discharge of site effluents, surface seeps, or release of water from storage areas west of the site to supplement water supplies in the Great Western Reservoir or Standley Lake. On North Walnut Creek, South Walnut Creek, and Woman Creek, a series of unlined ponds serve to impound waters from the site. Along North Walnut Creek, the ponds are numbered A-1 through A-4; on South Walnut Creek, the ponds are numbered B-1 through B-5; and on Woman Creek, the ponds are numbered C-1 and C-2. Pond C-2 does not receive direct flow from Woman Creek; flow into Pond C-2 is from runoff into South Interceptor Ditch and then into Pond C-2.

Wastewater from industrial processes is treated at a treatment plant that is isolated from other sources and does not discharge to surface water features. Existing sanitary wastewater generation is estimated at approximately 260 million liters per year (L/yr) (70 million gallons per year [gal/yr]). Sanitary wastewater is treated and discharged to Pond B-3. Storm water runoff from the plant is conveyed in storm sewers that discharge to creeks on the undeveloped portion of the site. Discharges from Ponds A-3, A-4, B-3, B-5, and C-2 are monitored under the National Pollutant Discharge Elimination System permit program.

Terminal ponds (A-4, B-5, and C-2) are designed to capture the flow from a 100-year storm if maintained at less than 10 percent of capacity. Rocky Flats has exceeded the 10 percent capacity limit because of added monitoring requirements and associated delays in receiving approval for certain discharges.

Rocky Flats does not withdraw any water from streams on or near the site. All water for the plant is obtained from surface waters from the City of Denver via the South Boulder Diversion Canal from the South Boulder Creek and Ralston Reservoir. The water supply contract with the City and County of Denver through the Denver Water Board is for an unguaranteed supply of up to 5.7 million L/day (1.5 million gal/day). This equates to about 2 billion L/yr (550 million gal/yr). The current average water consumption is approximately 485 million L/yr (128 million gal/yr). Raw water is stored in a 5.7-million L (1.5-million gal) storage pond west of the plant.

- *Surface Water Quality*—The water from Woman Creek, North Walnut Creek, and South Walnut Creek flows into ponds that restrict offsite discharges, allow water testing, and permit any treatment necessary to meet water quality standards. A treatment facility is located at Pond A-4, and water from Pond B-5 is transferred to Pond A-4. Treatment consists of filtration and carbon absorption to reduce potential radionuclides and organic chemical contaminants.

  With permission from the Colorado Department of Public Health and Environment, water is released from Pond A-4 to Walnut Creek and from Pond C-2 to Woman Creek.

  Discharges from Ponds A-4 and B-5 enter Walnut Creek and are diverted around the Great Western Reservoir by the Broomfield Diversion Ditch. Pond C-2 discharges to Woman Creek, which flows into recently constructed Woman Creek Reservoir immediately east of Indiana Street.

  An unlined surface water control pond exists immediately downstream and downhill from the landfill and from current waste disposal operations at the eastern end of the landfill. The landfill is considered a hazardous waste management landfill due to the past disposal of some materials that may now qualify as regulated hazardous wastes. The landfill pond routinely exceeds the Rocky Flats standard for strontium and has exceeded standards for copper, iron, lithium, manganese, mercury, nickel, plutonium, and zinc. Water in the landfill pond is transferred to Pond A-3, detained, and monitored during discharge to Pond A-4. No Notices of Violation under the National Pollutant Discharge Elimination System were received by the site during the 1993-1996 period. Additional information about surface

water quality at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

- *Surface Water Rights and Permits*—Surface water rights are not an issue at Rocky Flats because Rocky Flats facilities do not withdraw surface water for use. As previously mentioned, the water supply contract with the City and County of Denver is for an unguaranteed supply of up to 5.7 million L/day (1.5 million gal/day).

❒ **Groundwater—**Two hydraulically connected groundwater systems are present at Rocky Flats. The upper hydrostratigraphic unit exists as an unconfined system while the lower unit is a semi-confined system. The contact separating the two units is identified as the base of the weathered zone.

The unconfined system at Rocky Flats is composed primarily of unconsolidated sand, gravel, and clay. The average depth to the water table in the unconsolidated surficial deposits ranges from about 21 m (70 ft) at the western boundary of Rocky Flats to less than 3 m (10 ft) in the industrial area. Seeps are common along stream drainage. Groundwater flow direction is generally toward the east. Recharge to the unconfined aquifer occurs from infiltration of precipitation and as seepage from ditches, creeks, and ponds. In addition, unlined retention ponds along South Walnut and Woman Creeks probably recharge this unit.

In the semi-confined system, groundwater is in discontinuous sandstone lenses within claystone bedrock. Flow within the sandstones is assumed to be from west to east. In some places, the sandstones are in contact with the alluvium so that the unit is part of the unconfined system at those places. Recharge to the sandstones occurs where they are in direct contact with the alluvium and valley fill of the upper hydrostratigraphic unit or by leakage through claystones in contact with alluvium.

- *Groundwater Quality*—Groundwater monitoring has been conducted at Rocky Flats since 1960. By the end of 1994, approximately 400 wells were monitored to determine the groundwater quality and the distribution of contaminant constituents in groundwater at Rocky Flats. Groundwater quality in uncontaminated portions in surficial materials (alluvium, colluvium, valley fill, and weathered bedrock) is relatively good and can be classified as calcium bicarbonate water. The semi-confined system can be distinguished from the surficial system by relatively higher sodium and sulfate content.

  The unconfined system contains both radiological and nonradiological contaminants. To date, there are no known bedrock pathways through which groundwater contamination can directly leave Rocky Flats and migrate into the confined aquifer system offsite (DOE 1996a). Additional information about groundwater quality at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

- *Groundwater Availability, Use, and Rights*—Currently, no groundwater is used for drinking purposes by the facility. Approximately 10.6 million L/yr (2.8 million gal/yr) of groundwater is withdrawn from the site for contaminant removal as part of the environmental restoration program.

  Generally, the rights to groundwater resources in Colorado are unrelated to ownership of the land over those groundwater resources. For the Denver Basin aquifers, which include the lower systems at Rocky Flats, however, the right to groundwater resources derives from land ownership as long as the water is not tributary to any surface water supplies.

3.1.5 Geology, Soils, and Seismology

- **Geology—**Rocky Flats is located on the western edge of the Colorado Piedmont section of the Great Plains Province. The site is located on the west flank of the Denver Basin, an extensive sedimentary basin bordered on the west by the base of the Colorado Front Range. The site is located on a geomorphic surface composed of gravel on sand and clay.

The surface geology at Rocky Flats consists of rock fragments, sand, and gravel deposits that range in thickness from several centimeters to more than 30.5 m (100 ft). The most important unit is Rocky Flats Alluvium, which consists of deposits of sand, gravel, and cobbles in a clay matrix that thins from west to east across the site (DOE 1985). The Arapahoe Formation (Cretaceous period, formed from 65 million to 130 million years ago), which immediately underlies the Rocky Flats Alluvium at Rocky Flats, is approximately 0 to 36.5 m (0 to 120 ft) thick and consists of claystones with interbedded sandstones and siltstones (DOE 1985; DOE 1994a).

Landslides and other mass earth movements are present as shallow features where slopes are steep. Nearly all of the site, however, has slopes averaging only 2 percent. Slopes may be greater than 2 percent along the sides of washes.

- **Soils—**Rocky Flats is underlain mainly by soils of the Denver-Kutch and Flatirons-Velscamp soil associations. The erosion potential of the Denver-Kutch soil is low to moderate; shrink-swell potential is moderate to high. The Flatirons-Velscamp soil does not pose an erosion hazard; its shrink-swell potential is low to moderate.

- **Seismology—**Rocky Flats lies in Seismic Zone 1, indicating minor damage could occur as a result of earthquakes. No major faults cut the Arapahoe Formation or overlying alluvium in the vicinity of Rocky Flats. The Livingston fault, located approximately 5 km (3 mi) to the west, and the Golden fault, located approximately 8 km (5 mi) to the south, are the mountain-front faults closest to the facility. Neither fault is recognized as a capable fault according to 10 CFR Part 100, Appendix A. No other capable faults are present in the immediate vicinity of Rocky Flats. There are no active volcanos in the Denver Basin (DOE 1996a). Additional details are in Appendix D, Section D.3.3.3.1.

3.1.6 Ecology

- **Terrestrial Resources—**Rocky Flats is located at an elevation of 1,829 m (6,000 ft) above sea level, at the approximate elevation where plains grassland vegetation meets lower montane forest. Plant facilities occupy approximately 6 percent of the total site area, and the buffer zone around the site is primarily undeveloped. Vegetative communities on Rocky Flats have been divided into four basic types: grassland, marshland, woodland, and shrubland. Grassland is the most common community onsite, with mesic and zeric grasslands being the predominant subtypes. Marshland occurs along several creeks that cross the site. Woodlands and shrublands are not common communities on Rocky Flats. Habitats that are considered important to wildlife (especially waterfowl and passerine birds) include riparian zones along creeks and trees on south facing slopes. A total of 362 species of vascular plants have been identified on the site (DOE 1996a).

Vegetation is recovering from the grazing that occurred before Government acquisition of the land. Most areas formerly mapped as annual weed communities now qualify as perennial grassland. Indicator species for perennial grassland, such as western wheatgrass and Canada bluegrass, have increased in abundance and now dominate over much of the site (DOE 1996a).

Animals identified on Rocky Flats include 4 amphibian, 8 reptile, 167 bird, and 36 mammal species. Common animals of the site include the common bull snake, prairie rattlesnake, western meadowlark, mourning dove, coyote, and mule deer (DOE 1996a). A variety of game animals occur on the site; however, hunting is not permitted. Numerous raptors, such as the red-tailed hawk and rough-legged hawk, and carnivores, such as the coyote and long-tailed weasel, are found on Rocky Flats. Migratory birds and their nests and eggs are protected by the Migratory Bird Treaty Act (16 U.S.C. 703-711). Eagles are protected by the Bald Eagle Protection Act (16 U.S.C. 668-668D).

- **Wetlands**—Rocky Flats contains a variety of wetlands, including intermittent streams, ditches, ponds, and hillside seeps. Most wetlands that occur onsite are found along ephemeral streams and are classified as palustrine. Several manmade wetlands exist on the site, including vegetated sections of ditches, such as the South Interceptor Ditch, the A, B, and C-series ponds, and the landfill pond. Additionally, various locations around the site have wetlands that are fed by drains and storm water from paved areas and other surface runoff (DOE 1996a). Numerous seeps are scattered on the hillsides of the site. Vegetation typical of wetlands at Rocky Flats includes sandbar willow, American watercress, plains cottonwood, broad-leaf cattail, and bulrush. In total, there are approximately 43 ha (107 acres) of non-riparian wetlands and 26 km (16 mi) of riparian wetlands within Rocky Flats (DOE 1996a).

- **Aquatic Resources**—Aquatic habitat on Rocky Flats consists of ephemeral streams, ditches, ponds, and springs. Four streams flow within the site boundaries: North Walnut Creek, South Walnut Creek, Woman Creek, and Rock Creek. Each of these streams supports a series of on-channel retention reservoirs or ponds that collect surface water runoff and wastewater.

North and South Walnut Creek, which are located in the northeast portion of the site, flow eastward offsite and into Great Western Reservoir. Fathead minnows are found in these streams. There are three holding ponds along North Walnut Creek and four ponds along South Walnut Creek. These ponds support crayfish and various other macroinvertebrates.

Woman Creek, which is located in the southern portion of the site, flows eastward offsite and into Standley Lake. Seven species of fish have been identified in Woman Creek, including several minnows, largemouth bass, green sunfish, and the white sucker (DOE 1996a).

- **Threatened and Endangered Species**—The 43 Federal- and State-listed threatened, endangered, and other special-status species that may be found on or in the vicinity of Rocky Flats area are listed in **Table 3–6.** Sixteen of these species have been observed on or near the site. Potential suitable habitat for 27 other species exists on Rocky Flats. No critical habitat for threatened or endangered species, as defined in the Endangered Species Act, exists on Rocky Flats.

Three Federally listed threatened or endangered species (bald eagle, peregrine falcon [both subspecies], and Preble's meadow jumping mouse, are known to occur on the Rocky Flats site. Bald eagles have been observed flying over and occasionally foraging on Rocky Flats and are known to roost at Standley Lake and Great Western Reservoir, approximately 1.8 km (1.1 mi) and less than 0.5 km (0.3 mi), respectively, from the site. Peregrine falcons have been observed flying over and hunting onsite. Two historical nest sites are within 16 km (10 mi) of the site. The Preble's meadow jumping mouse is known to occupy riparian corridors and impoundment margins at the site. The U.S. Fish and Wildlife Service published a proposal to list the Preble's meadow jumping mouse as an endangered species in March 1997 (62 FR 14093). On May 13, 1998, the U.S. Fish and Wildlife Service published a final rule listing the Preble's meadow jumping mouse as a threatened species (USFWS 1998).

Ute ladies'-tresses are known to occur approximately 13 km (8 mi) north of the site in Boulder County. Suitable habitat exists on Rocky Flats for this species, but no specimens were found during site surveys. Although the complex of prairie dog towns on the site provides suitable habitat for the endangered black-footed ferret, occurrence of the ferret is highly unlikely (DOE 1991), and the area has been cleared of the requirement for verifying surveys (DOE 1996a).

Four Federal candidate species occur on Rocky Flats. Western burrowing owls have been observed in prairie dog colonies at the site. Loggerhead shrikes are seen year-round and usually are seen at the edges of the grasslands adjoining woodlands and shrublands. The ferruginous hawk is a fall and winter resident of the site and has been reported onsite during the breeding season. Although any of these species may breed on Rocky Flats, no breeding activities have been confirmed.

Suitable habitat for the eastern short-horned lizard exists on approximately one-third of the site and this species has been recorded sitewide. The northern goshawk and Baird's sparrow have been observed onsite but are both considered occasional migrant visitors.

Table 3–6 Federal- and State-Listed Threatened, Endangered, and Other Special Status Species that may be Found at or in the Vicinity of Rocky Flats

Federal Endangered Species Known to Occur at Rocky Flats	
Birds	American Peregrine Falcon (*Falco peregrinus*)[1] (ST)[2]
Federal Threatened Species Known to Occur at Rocky Flats	
Birds	Bald Eagle (*Haliaeetus leucocephalus*)[3] (ST)
Mammals	Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*) (SC)
Federal Special-Concern Species Known to Occur at Rocky Flats	
Reptiles	Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostra*)[4, 5]
Birds	Northern Goshawk (*Accipiter gentilis*)[5, 6]
	Baird's Sparrow (*Ammodranius bairdii*)[5]
	Western Burrowing Owl (*Athene cunicularia hypugea*)[4, 5]
	Ferruginous Hawk (*Buteo regalis*)[4, 5] (SC)[7]
	Black Swift (*Cyseliodes niger*) [5, 6]
	Loggerhead Shrike (*Lanius ludovicianus*)[4, 5]
	White-faced Ibis (*Plegadis chihi*)[5]
Mammals	Small-footed Myotis (*Myotis subulatus = M. ciliolabrum*)[5, 6]
Colorado Species of Special Concern Known to Occur at Rocky Flats	
Amphibians	Northern Leopard Frog (*Rana pipiens*) (SC)
Birds	Long-billed Curlew (*Numenius americanus*)[6] (SC)
	Greater Sandhill Crane (*Grus canadensis tibida*)[6] (ST)
	American White Pelican (*Pelecanus erythrorhynchos*)[4] (SC)
Federal Endangered Species with Potential Habitat at Rocky Flats	
Birds	Whooping Crane (*Grus americana*)
	Least Tern (*Sterna antillarum*)
	Piping Plover (*Charadrius melodus*)
Mammals	Black-footed Ferret (*Mustela nigripes*)[8]
Federal Threatened Species with Potential Habitat at Rocky Flats	
Plants	Ute Ladies'-tresses (*Spiranthes diluvialis*)[9]
Insects	Pawnee Montane Skipper (*Hesperia leonardus montana*)
Federal Candidate Species with Potential Habitat at Rocky Flats	

Plants	Colorado Butterfly Plant (*Gaura neomexicana var. coloradensis*) (Cl)[10]
Birds	Mountain Plover (*Charadrius montanus*) (Cl)
	Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Cl)

Federal Special-Concern Species with Potential Habitat at Rocky Flats	
Plants	Bell's Twinpod *(Physaria bellii*)[5]
	Tulip Gentian (*Eustoma grandiflora*)[5]
	Adder's Mouth Orchid (*Malaxis brachypoda*)[5]
Insects	Regal Fritillary (*Speyeria idalia*)[5]
Fish	Plains Topminnow (*Fundulus sciadicus*)[5]
Birds	Western Snowy Plover (*Charadrius alexandrinus nivosus*)[5]
	Black Tern (*Chlidonias niger*)[5]
Mammals	Spotted Bat (*Euderma maculatum*)[5]
	Long-eared Myotis (*Myotis evotis*)[5]
	Fringed Bat (*Myotis thysanodes*)[5]
	Long-legged Myotis (*Myotis volans*)[5]
	Pale Townsend's Big-eared Bat (*Plecotus townsendii pallescens*)[5]
	Plains Spotted Skunk (*Spilogale putorius interrupta*)[5]
	Swift Fox (*Vulpes velox*)[8, 5]
Colorado Species of Special Concern with Potential Habitat at Rocky Flats	
Fish	Common Shiner (*Notropis conutus*) ((SC)
	Stonecat (*Noturus flavus*) (SC)
Birds	Barrow's Goldeneye (*Bucephala islandica*) ((SC)
	Plains Sharp-tailed Grouse (*Tympanuchus phasianellus jamesi*) (SE)[11]

Notes:

1. The species *Falco peregrinus* is listed as endangered wherever found in the coterminous 48 states. Some subspecies are listed separately.
2. Colorado State threatened species (ST)
3. The U.S. Fish and Wildlife Service has down-listed the Bald Eagle to threatened status.
4. This species is resident or regularly visits Rocky Flats.
5. In February 1996, the U. S. Fish and Wildlife Service revised the list of candidate species. All former candidate species except C-1 species are now classified unofficially as "at risk" and are still considered special-concern species. This table includes these species because they may be upgraded to C-1 species at any time.
6. The species has been observed infrequently on Rocky Flats.
7. Colorado species of special concern (SC).
8. This species was previously collected near Rocky Flats.
9. These species have historically used areas in the vicinity, and suitable habitat exists at Rocky Flats.
10. Federal candidate species for listing as threatened or endangered (C-1).
11. Colorado State endangered species.

Source: DOE 1997b.

3.1.7 Cultural and Paleontological Resources

Thirty-five historic sites have been identified at Rocky Flats. Most of the historic resources in the area are archaeological sites or standing structures associated with ranching or transportation routes. Several Native American groups, including the Plains Apache, Comanche, Ute, Arapaho, and Cheyenne, historically occupied or crossed the foothills around Rocky Flats. No paleontological materials have been recovered from the Rocky Flats alluvium, and it is considered nonfossiliferous. Additional information about cultural resources at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

3.1.8 Socioeconomics

- **Regional Economy Characteristics—**Between 1980 and 1990, the civilian labor force in the regional economic area increased 39.9 percent to the 1990 level of 1,868,628. The regional economic area encompasses 49 counties around Rocky Flats located in Colorado, Nebraska, and Kansas. The 1994

unemployment rate in the regional economic area was 4.1 percent, which parallels the unemployment rate for Colorado. The unemployment rate for Kansas is approximately 1 percent higher than that of the regional economic area, and Nebraska is about 1 percent lower than the regional economic area unemployment rate. The region's per capita income of $21,958 in 1993 was approximately 2 percent greater than Colorado's per capita income of $21,498. The Kansas per capita income ($19,849) was 9.6 percent lower than the region's, and Nebraska's per capita income ($19,673) was 10.4 percent lower (DOE 1996a).

The composition of the regional economic area economy was similar to that of the statewide economy of Colorado. During 1993, the services sector constituted more than 31 percent of the region's total employment, followed by retail trade (approximately 17 percent) and manufacturing (approximately 9 percent). For Colorado, the service sector accounted for slightly more than 30 percent of the total employment, retail trade accounted for 17 percent, and manufacturing accounted for 8 percent. Kansas and Nebraska paralleled each other, with the service sector representing 25 and 26 percent, respectively, of total employment, retail trade representing 17 percent for both States, and manufacturing representing 12 and 10 percent, respectively (DOE 1996a).

- **Population and Housing—**In 1994, the region of influence population totaled 1,957,797. The region of influence is a five-county area (Adams County, Araphahoe County, Boulder County, Denver County, and Jefferson County) located in Colorado in which over 90 percent of all Rocky Flats employees reside. From 1980 to 1994, the region of influence population grew by 22.9 percent, compared to 26.5 percent for Colorado. Within the region of influence, Arapahoe County experienced the greatest population increase, 51.2 percent; Denver County's population increased by only 0.2 percent (DOE 1996a).

The increase in number of housing units in the region of influence between 1980 and 1990, 22.5 percent, was about 1 percent less than the increase in Colorado housing units. The total number of housing units in the region of influence for 1990 was 788,480. The 1990 region of influence homeowner and renter vacancy rates, 3.2 and 11.7 percent, respectively, were similar to those in Colorado (DOE 1996a).

Figure 3–6 shows the racial and ethnic composition of minorities residing within an 80-km (50-mi) radius of Rocky Flats at the time of the 1990 census. This 80-km (50-mi) radius defines the region of potential influence for radiological impacts evaluated in Chapter 4 of this EIS. The minority population as a percentage of total population residing in the region of influence was approximately 5 percent less than the national percentage of minorities residing in the continental United States at the time of the 1990 census (24.2 percent). Hispanics comprised nearly 63 percent of the minority population in the region of influence (DOE 1996a).

Figure 3–7 illustrates the geographical distribution of the minority population living within the region of influence expressed as a percentage of the total population. Areas in which the percentage minority population exceeded the national average by a factor of 1.5 or more are designated with horizontal and vertical crosshatching. Areas with the largest percentage minority population are found within the City of Denver and along Highway 85 near Fort Lupton and Greeley (DOE 1996a).

As shown in Table F-3 of Appendix F, approximately 10 percent of the individuals living within the region of influence had a self-reported income less than the poverty level. The poverty level is a function of family size and number of unmarried children in the family under 18 years of age (Appendix F). The national percentage of individuals with income less than the poverty-level in 1995 is estimated by the Census

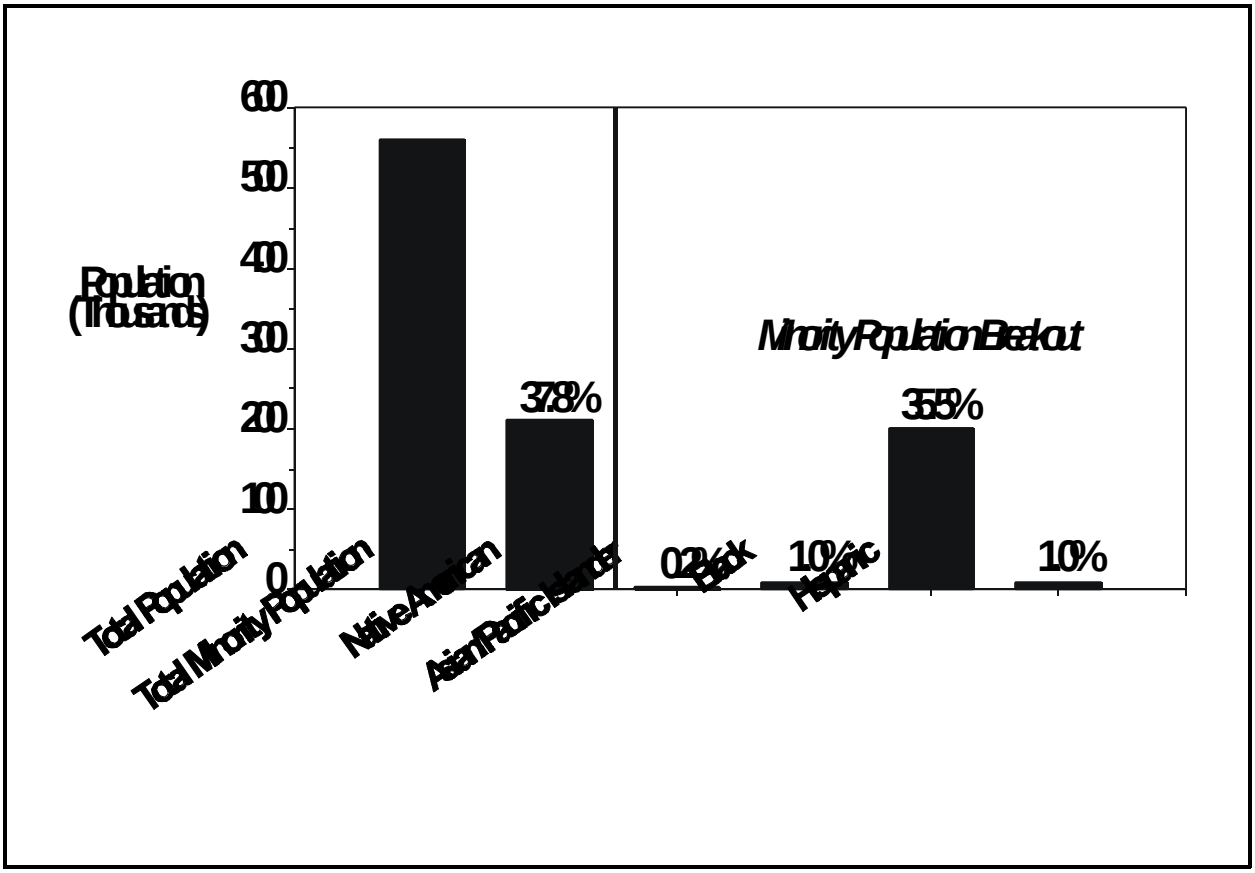


Figure 3–6 Racial and Ethnic Composition of the Minority Population Residing Within 80 km (50 mi) of Rocky Flats

Bureau to be 13.8 percent. At the time of the 1990 census, the national percentage of individuals with income less than the poverty level for the continental United States was 13.3 percent. **Figure 3–8** shows the distribution of poverty-level individuals living within the region of influence.

- **Education—**In 1994, 18 school districts provided public education services and facilities in the Rocky Flats region of influence. These school districts operated at between 67.5-percent (Denver County School District) and 102.5-percent (Byers School District) capacity. The average student-to-teacher ratio for the Rocky Flats region of influence in 1994 was 19:1. The Jefferson County School District had the highest ratio at 23.7:1.

- **Public Safety—**City, county, and State law enforcement agencies provide police protection to the residents of the region of influence. In 1994, a total of 3,811 sworn police officers were serving the 5-county region of influence. The City of Denver employed the largest number of officers (1,378) and had the highest officer-to-population ratio (2.8 sworn officers per 1,000 persons). The average region of influence officer-to-population ratio was 2.0 officers per 1,000 persons.

Fire protection services in the Rocky Flats region of influence were provided by 5,408 regular and volunteer firefighters in 1995. The fire district with the highest firefighter-to-population ratio was Adams County, with 9.5 firefighters per 1,000 persons. Adams County also employed the greatest number of firefighters (1,396). The average firefighter-to-population ratio in the region of influence was 2.7 firefighters per 1,000 persons.

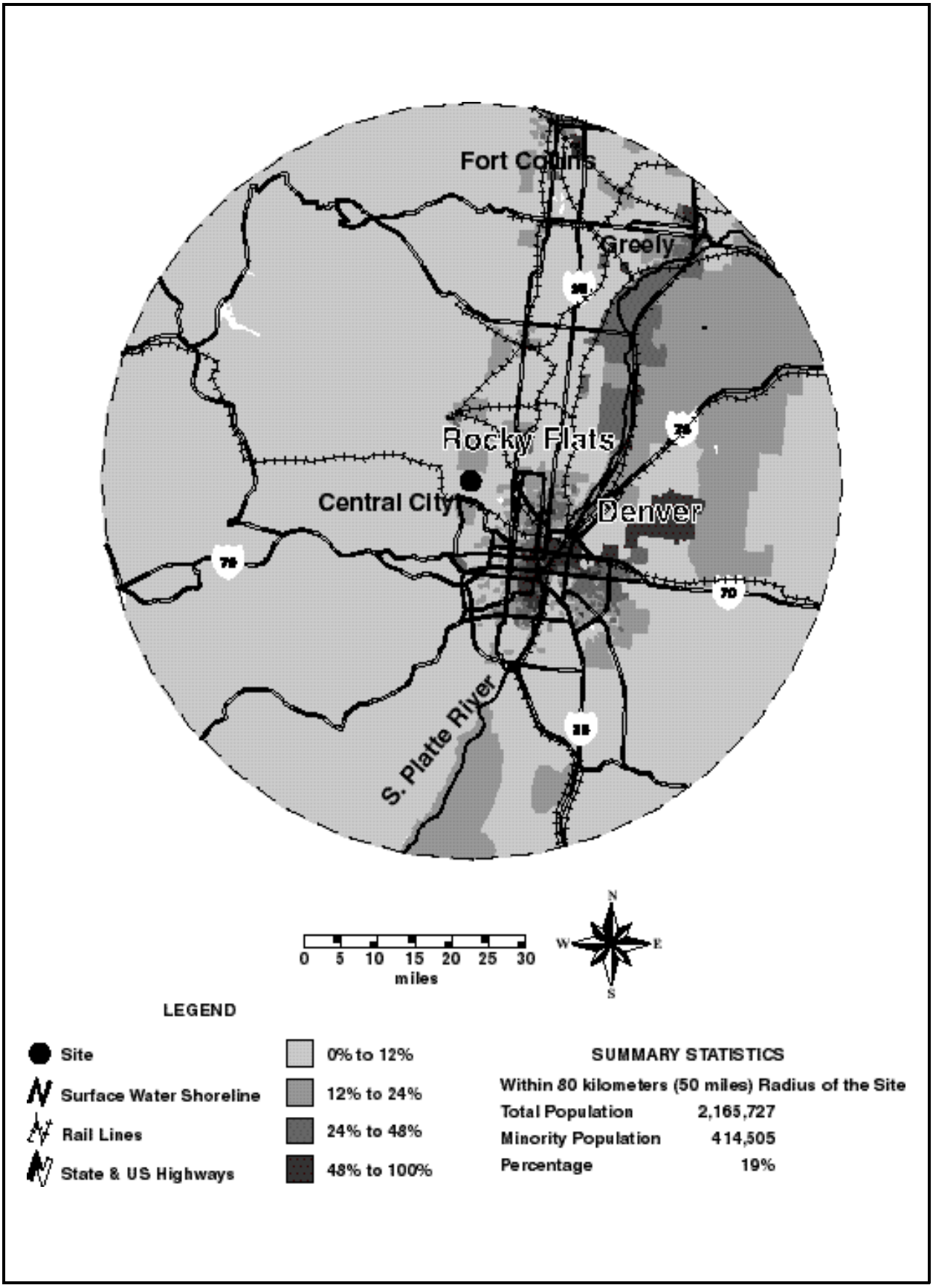


Figure 3–7 Distribution of Minority Population Living Within 80 km (50 mi) of Rocky Flats

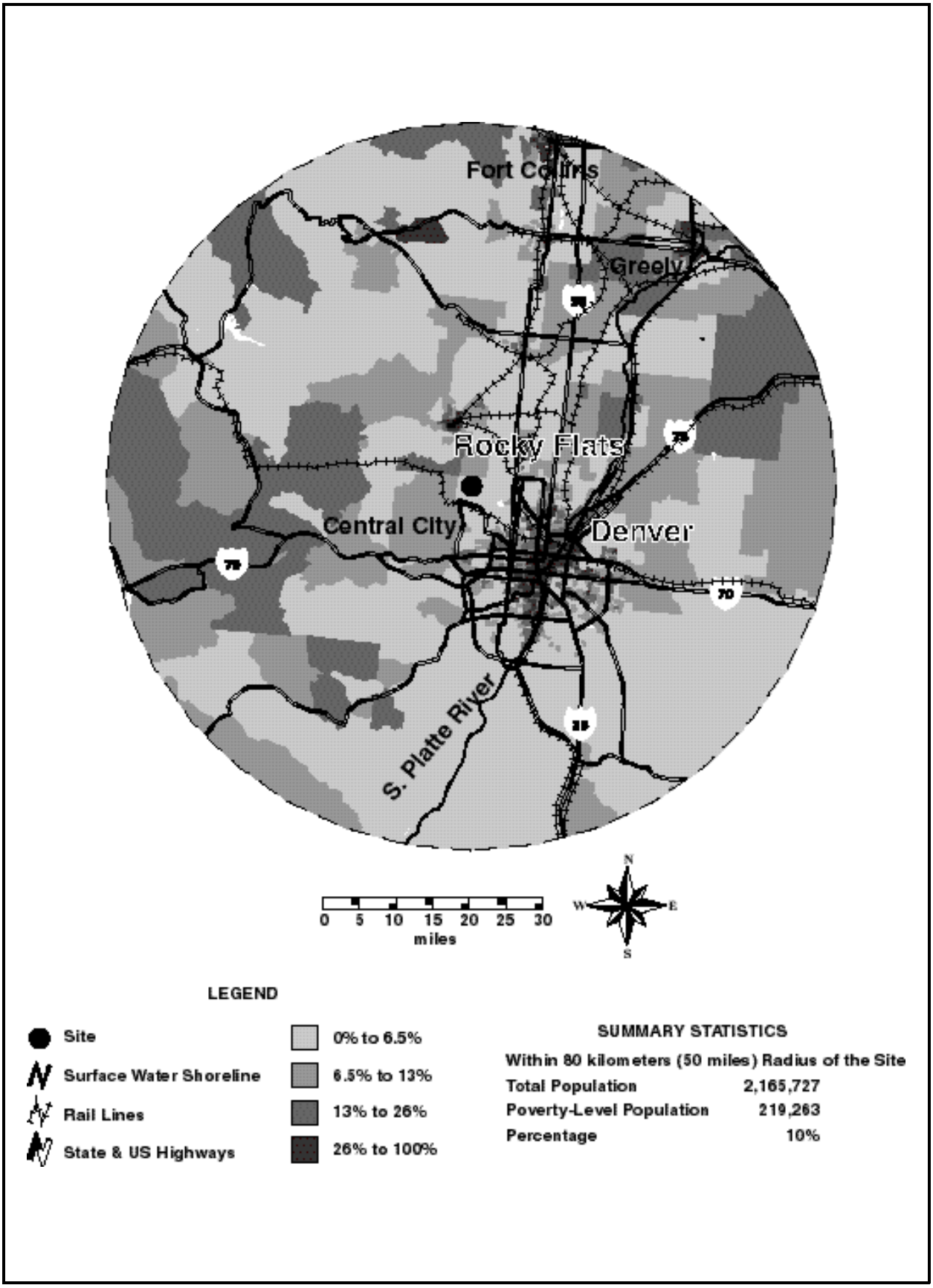


Figure 3–8 Distribution of Poverty-level Population Living Within 80 km (50 mi) of Rocky Flats

- **Health Care—**Nineteen hospitals served the five-county region of influence in 1994. More than 64 percent of the hospital bed capacity was located in 9 hospitals in the City of Denver. During 1994, all 19 hospitals operated at below capacity, with bed occupancy rates ranging from 22.4 percent in Adams County to 60.2 percent in Denver County.

During 1994, 5,017 physicians practiced in the region of influence with the majority (2,649) operating in Denver County. Physician-to-population ratios ranged from 1.2 physicians per 1,000 persons in Jefferson County to 5.4 physicians per 1,000 persons in Denver County. The average region of influence physician-to-population ratio was 2.6 physicians per 1,000 persons.

- **Local Transportation—**Vehicular access to Rocky Flats is provided by Colorado State Highway 93 to the west and Jefferson County Road 17 (Indiana Street) to the east. Road improvements for segments providing access to Rocky Flats include bridge replacement and reconstruction along Colorado State Highway 93 before the year 2000. There are no current road improvements that would affect access to Rocky Flats. There is no public transportation to Rocky Flats (DOE 1995c).

Major railroads in the region of influence include the Union Pacific, the Burlington Northern and Santa Fe Railroad, and the Union Pacific Railroad. A single-track spur from the Union Pacific main line enters Rocky Flats from the west. No navigable waterways within the region of influence are capable of accommodating waterborne transportation of material shipments to Rocky Flats (DOE 1993a). The Denver International Airport, which began operation in 1995, provides passenger and cargo service in the region of influence on national and international carriers.

3.1.9 Public and Occupational Health and Safety

- **Radiation Environment—**Major sources and levels of background radiation exposure to individuals in the vicinity of Rocky Flats are shown in **Table 3–7.** Annual background radiation doses to individuals remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to Rocky Flats operations.

Releases of radionuclides to the environment from Rocky Flats operations provide another source of radiation exposure to individuals in the vicinity of Rocky Flats. Types and quantities of radionuclides released from Rocky Flats operations in 1994 are listed in the *Site Environmental Report for 1994* (Kaiser-Hill 1995). Doses to the public resulting from these releases are presented in **Table 3–8.** These doses fall within radiological limits stated in DOE Order 5400.5 and are small in comparison to background radiation.

Workers at Rocky Flats receive the same dose as the general public from background radiation; they receive an additional dose from working in the facilities. **Table 3–9** presents the average and cumulative dose to Rocky Flats workers from operations in 1996.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Site Environmental Report for 1994* (Kaiser-Hill 1995). Concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in this reference.

Table 3–7 Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Rocky Flats Operations

Source	*Effective Dose Equivalent (mrem/yr)*
Natural Background Radiation[a]	
Cosmic and cosmogeneric radiation	51
External terrestrial radiation	63
Internal terrestrial radiation	39
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	< 1
Air travel	1
Consumer and industrial products	10
Total	418

[a] DOE 1994a.
[b] NCRP 1987.
Note: Value for radon is an average for the United States.

Table 3–8 Radiation Doses to the Public from Incident-Free Rocky Flats Operations in 1994 (Committed Effective Dose Equivalent)

Members of the General Public	*Atmospheric Releases*		*Liquid Releases*		*Total*	
	Standard[a]	*Actual*	*Standard*[a]	*Actual*	*Standard*[a]	*Actual*
Maximally exposed individual (mrem)	10	0.14	4	~0	100	0.14
Population within 80 km (50 mi)[b] (person-rem)	None	0.26	None	0[c]	None[d]	0.26
Average individual within 80 km (50 mi)[e] (mrem)	None	0.00012	None	0[c]	None	0.00012

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that Order, the 10 mrem/yr limit from airborne emissions is required by the Clean Air Act, the 4 mrem/yr limit is required by the Safe Drinking Water Act, and the total dose of 100 mrem/yr is the limit from all pathways combined.
[b] In 1994, this population was approximately 2,200,000.
[c] No population groups are exposed to any liquid pathways.
[d] A 100 person-rem value for the population is given in proposed 10 CFR Part 834 (58 *Federal Register* 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.
[e] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.
Source: Kaiser-Hill 1995.

Table 3–9 Radiation Doses to Workers from Incident-Free Rocky Flats Operations in 1996 (Committed Effective Dose Equivalent)

Occupational Personnel	*Onsite Releases and Direct Radiation*	
	Standard [a]	*Actual*
Average worker (mrem)	None	57
Total workers[b] (person-rem)	None	263

[a] DOE's goal is to maintain radiological exposures as low as reasonably achievable. This includes maintaining doses to individual workers so far below the DOE limit of 5,000 mrem/year (10 CFR Part 835) that no dose is expected to exceed the DOE Administrative Control Level of 2,000 mrem/year (DOE 1992a).

[b] The number of badged workers in 1996 was approximately 4,600.
Source: DOE 1997b.

- **Chemical Environment—**The background chemical environment important to human health consists of the atmosphere (hazardous chemicals may be inhaled), drinking water (hazardous chemicals may be swallowed), and other parts of the environment people encounter (such as surface waters during swimming and soil through direct contact or via the food pathway).

Effective administrative and design controls help minimize potential health impacts to the public by decreasing hazardous chemical releases to the environment and by helping achieve compliance with permit requirements, such as air emissions and National Pollutant Discharge Elimination System permit requirements. The effectiveness of these controls is verified through the use of monitoring information and the inspection of mitigation measures. During incident-free operations at Rocky Flats, health impacts to the public may occur from breathing air containing hazardous chemicals released to the atmosphere by Rocky Flats operations. Other risks to public health, such as drinking contaminated water or direct exposure, are low compared to risks from breathing.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data already presented in Section 3.1.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations.

Exposure pathways to Rocky Flats workers during incident-free operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a detailed estimation and summation of these impacts. However, the workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Rocky Flats workers are also protected by adherence to Occupational Safety and Health Administration and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that shows the frequency and amounts of chemicals used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements (DOE Order 440.1) ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm.

- **Emergency Preparedness—**Each of DOE's sites have established an emergency management program that would be activated in the event of an accident. Each program has been developed and maintained to ensure adequate response for most accident conditions. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

Rocky Flats has emergency plans that provide guidance and procedures designed to protect: (1) life and property within the facility, (2) the health and welfare of surrounding metropolitan communities, and (3) the defense interests of the Nation during any credible emergency situation. Mutual assistance and coordination with Federal, State, and local agencies is provided on a cooperative basis.

DOE's Rocky Flats Area Office Manager coordinates activities for emergencies affecting offsite personnel or property and is responsible for communication with the supporting Federal, State, and local agencies. The Rocky Flats Area Office Manager may obtain further assistance through the Interagency Radiological Assistance Plan, which provides that each of the signatory Federal agencies will assist one another in the event of a major emergency involving radioactivity.

The Rocky Flats Emergency Plan is designed to enable Rocky Flats to be as self-sufficient as possible in handling onsite emergency situations. Assistance may be requested from outside sources through written agreements with St. Anthony Hospital, St. Luke's Hospital, the University of Colorado, the Jefferson County Sheriff's Office, and the Federal Bureau of Investigation.

In the event of an offsite emergency, the *Rocky Flats Radiological Assistance Plan* interfaces with the *DOE Radiological Assistance Plan*, the *Interagency Radiological Assistance Plan*, and the Joint Nuclear Accident Coordinating Center through the DOE Rocky Flats Area Office at Rocky Flats. Additionally, in the event of an incident at Rocky Flats involving the release of radioactive material that may endanger the health and safety of the general public, the *Colorado Radiological Emergency Response Plan* would be activated.

3.1.10 Waste Management

Table 3–10 presents a summary of waste management activities at Rocky Flats for 1995. DOE is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at Rocky Flats. DOE engaged in several activities to bring its operations into regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for complying with applicable requirements and financial penalties for not meeting agreed-upon milestones.

The focus of the Rocky Flats mission is on stabilization, decommissioning, and environmental restoration. The legal framework establishing the scope, schedule, and approach for projects in the cleanup program is the Rocky Flats Cleanup Agreement, which provides a uniform framework for decommissioning, waste management, and environmental restoration onsite. The agreement integrates the actions required under the authority and jurisdiction of the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act. The primary objective of the environmental restoration program is to assess and to clean up Rocky Flats in compliance with applicable environmental laws and regulations.

Rocky Flats manages the following waste categories: transuranic, low-level, hazardous, toxic substances, mixed, and nonhazardous. Waste management includes the treatment, storage, shipment, and disposal of waste. Waste disposal activities include disposal of low-level waste and low-level mixed waste at the Nevada Test Site, Envirocare of Utah, and the Hanford Site; preparing, transporting, and disposing of hazardous and other regulated wastes by commercial vendors; and the disposing of sanitary waste in the onsite landfill. A discussion of the waste management operations associated with each waste category follows.

- **Transuranic Waste—**Transuranic and mixed transuranic wastes generated at Rocky Flats before 1970 were shipped to Idaho National Environmental Engineering Laboratory and disposed of underground. After 1970, this waste was shipped to Idaho National Environmental Engineering Laboratory for interim storage until a permanent disposal facility becomes available. As a result of delays in opening the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, the Governor of Idaho placed a moratorium on out-of-state waste shipments to Idaho National Environmental Engineering Laboratory in October 1988, forcing Rocky Flats to store transuranic and mixed transuranic wastes onsite.

Table 3–10 Waste Management Activities at Rocky Flats

Waste Category	*1996 Generation[a] (m^3)*	*Treatment Method*	*Treatment Capacity (m^3/yr)*	*Storage Method*	*Storage Capacity (m^3)*	*Disposal Method*	*Disposal Capacity*
Transuranic							
Liquid	None	Solidification	Included in liquid mixed LLW	None	N/A	NA	NA
Solid	25	Compaction	Included in solid mixed LLW	Drums on pads	1,500[b]	None - WIPP or alternate facility in the future	NA
Transuranic (Mixed)							
Liquid	None	Solidification	Included in liquid mixed LLW	None	N/A	NA	NA
Solid	5	Compaction	Included in solid mixed LLW	Drums on pads	1,300[c]	None - WIPP or alternate facility in the future	NA
Low-Level							
Liquid	5	Evaporation and Solidification	Included in liquid mixed LLW	Staged	105[d]	NA	NA
Solid	617	None	None	Staged	4,540[d]	Offsite - DOE	NA
Hazardous							
Liquid	None	Neutralization & Precipitation	None	Staged in Department of Transportation containers	Included in solid hazardous waste	Offsite	NA
Solid	23 (tonnes)	None	None	Staged in Department of Transportation containers	263[e]	Offsite	NA
Mixed (Low-Level)							
Liquid	4	Solidification	47,700[f]	Staged for treatment	Included in solid mixed low-level waste	None	N/A
Solid	47	None	7,100[g,h]	Department of Transportation containers	13,600[i]	Offsite	N/A
Nonhazardous (Sanitary)							
Liquid	None	Sedimentation	568,000	None	N/A	Surface water	N/A
Solid	10,268 (tonnes)	None	None	None	N/A	Onsite landfill	Expandable

LLW = low-level waste N/A = Not applicable.

[a] Values per *Rocky Flats Comprehensive Waste Management Plan.*

[b] Value taken from *Draft Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste.*

[c] Value taken from *Rocky Flats Proposed Site Treatment Plan* dated March 1995 and is based on the sum of the current mixed-transuranic storage and the expected 20-year generation.

[d] Cumulative volume of low-level waste stored at the end of 1993 as per memorandum from McGlochlin, EG&G, to Reece, DOE, on updated information for non-nuclear consolidation Environmental Assessment.

[e] Value based on the 1991 Waste Storage Inventory Report and the memorandum from McGlochlin, EG&G, to Reece, DOE, on updated information for non-nuclear consolidation Environmental Assessment.

[f] Based on the operating capacities of Buildings 374 and 774 as described in the 1995 Mixed Waste Inventory Report.

[g] Based on the operating capacities of Building 776 as described in the 1995 Mixed Waste Inventory Report.

[h] Value calculated using the conversion ratio of 1,500 kg/m^3.

[I] Value taken from Rocky Flats Proposed Site Treatment Plan dated March 1995 and based on the mixed low-level waste in storage at Rocky Flats.

Sources: Adapted from DOE 1996a and DOE 1997a.

This onsite storage violated Resource Conservation and Recovery Act storage provisions and led to several interim agreements. Storage of transuranic and mixed transuranic wastes at Rocky Flats is governed by the provisions of the Colorado Department of Health Settlement Agreement and Compliance Order on Consent, Number 89-07-10-01, related to mixed wastes, that was signed on July 14, 1989. The Order required Rocky Flats to submit a Part A Permit Application for all its interim status mixed transuranic and mixed low-level waste storage and treatment units. The Order granted interim status to all mixed transuranic waste units, except Unit 60, included in applications filed by July 1, 1988, and also granted interim status to units used for storage and treatment of hazardous and mixed low-level waste identified in an August 2, 1988, Part A Application. The mixed residues were subsequently incorporated into the existing Rocky Flats Part B Permit for the treatment and storage of mixed and hazardous waste.

Finally, the Order set the total capacity limit for interim status container storage for mixed transuranic waste at 1,220 cubic meters (m^3) (1,601 cubic yards [yd^3]) (DOE 1996a), although a capacity exists for 1,500 m^3 (1,960 yd^3). The Federal Facility Compliance Act of 1992 requires DOE to develop site-specific mixed waste treatment plans and to submit the plans to the EPA or the authorized State for approval. The final proposed plan was published in March 1995.

Residues are process byproducts that contain plutonium in concentrations that would allow its recovery for a cost less than the cost of new plutonium. Initially, DOE did not consider residues at Rocky Flats to be a waste form. However, events at Rocky Flats have led to the classification of some of these plutonium residues as waste in the State of Colorado. Those residues that contain hazardous constituents have undergone characterization to determine compliance with the Resource Conservation and Recovery Act and court orders.

On November 3, 1989, DOE and the State of Colorado signed the Residue Compliance Agreement and Consent Order, which requires DOE to submit a plan for removing all mixed residue inventory at Rocky Flats by January 1, 1999. Also, the U.S. District Court, Colorado, issued a Judgment and Order on August 13, 1991, that declared Rocky Flats mixed residues to be hazardous materials that must be managed in accordance with the Resource Conservation and Recovery Act. This ruling further ordered that DOE must obtain a permit for the mixed residues without a Resource Conservation and Recovery Act permit. The mixed residues were subsequently incorporated into the existing Rocky Flats Part B Permit for the treatment and storage of mixed and hazardous wastes.

WIPP has specific Resource Conservation and Recovery Act hazardous waste codes that it can accept without requiring the treatment of the waste forms. After stabilization, Rocky Flats mixed wastes will not contain Resource Conservation and Recovery Act wastes outside of the acceptable waste codes for WIPP. WIPP's waste acceptance criteria must be met by each site seeking to ship mixed wastes to WIPP. Each site has developed a WIPP transuranic waste characterization program (including hazardous waste characterization) to meet the waste acceptance criteria.

- **Low-Level Waste—**Low-level waste has typically been packaged and disposed of at either the Nevada Test Site or the Hanford Site. Prior to shipment and acceptance for disposal at these facilities, each waste form must be characterized and shown not to contain Resource Conservation and Recovery Act hazardous constituents.

- **Mixed Low-Level Waste—**A great deal of the solid radioactive waste at Rocky Flats consists of mixed low-level waste. Mixed low-level waste shipments to the Nevada Test Site were suspended in May 1990 when the Resource Conservation and Recovery Act Land Disposal Restriction regulations went into effect. Low-level mixed waste is currently shipped to Envirocare of Utah for disposal. Prior to the acceptance of

any waste for disposal at Envirocare of Utah, DOE must fully characterize each waste to prove that hazardous constituents are below treatment standards.

DOE and EPA entered into a Federal Facility Compliance Agreement for Land Disposal Restriction wastes on May 20, 1991. This agreement requires DOE to submit the following: a Comprehensive Treatment and Management Plan addressing treatment proposed for Rocky Flats nonresidue mixed wastes to bring them into compliance with the treatment and storage requirements of the Resource Conservation and Recovery Act; a Waste Minimization Plan identifying process changes proposed to minimize or eliminate wastes; and an Annual Progress Report evaluating Rocky Flats' progress in achieving compliance with the Resource Conservation and Recovery Act Land Disposal Restriction.

Negotiations began in June 1992 for a new Federal Facility Compliance Agreement. This 1993 agreement was entitled the "Settlement Agreement and Compliance Order on Consent No. 93-04-23-01," and it replaced the 1991 Federal Facility Compliance Agreement and the 1989 Agreement in Principle. DOE continues to manage its mixed waste compliance program in accordance with the existing 1993 Settlement Agreement. For example, the Waste Minimization Program Plan, Waste Stream and Residue Identification and Characterization Report, and the Annual Progress Report continue to be updated and submitted on an annual basis. However, because the Federal Facility Compliance Act gives the State primacy in approval of the site treatment plan and issuance of a compliance order, the Colorado Department of Public Health and Environment is now considered the lead regulatory agency in regard to DOE's mixed waste compliance program.

- **Hazardous Waste—**Hazardous wastes are shipped to various Resource Conservation and Recovery Act-permitted commercial vendors for disposal. In 1991, DOE and the Colorado Department of Public Health and Environment agreed on radioactivity limits for waste garage oil. This waste form is now being shipped to a commercial vendor for recycling.

- **Nonhazardous Waste—**DOE and EPA agreed to and signed, on March 25, 1991, a Federal Facility Compliance Agreement for the National Pollutant Discharge Elimination System program. The agreement requires the following actions:

  - Upgrade the sewage treatment plant and change sewer sludge and spray irrigation management practices.
  - Enhance groundwater monitoring for the sewage sludge drying beds.
  - Prepare a compliance plan describing those actions necessary for Rocky Flats to remain in compliance with the National Pollutant Discharge Elimination System permit.
  - Submit to the EPA a variety of new reports and studies describing the status of compliance.

Solid sanitary waste will be sent to an off site landfill starting in fiscal year 1998. Liquid nonhazardous waste is treated and released to surface waters.

3.2 SAVANNAH RIVER SITE

The Savannah River Site is one of the Department of Energy's primary facilities for research and production of nuclear materials. It is also used for the interim management of radioactive waste. The site occupies 80,130 ha (198,000 ac) in portions of Aiken, Barnwell, and Allendale Counties in South Carolina and is adjacent to the border between South Carolina and Georgia. It is located approximately 19 km (12 mi) south of Aiken, South Carolina, and approximately 40 km (25 mi) southeast of Augusta, Georgia (**Figure 3–9**). The site was built in the early 1950s to produce nuclear materials used to manufacture nuclear weapons. Today, the site includes 16 major production, service, research, and development areas, not all of which are currently in operation.

There are more than 3,000 facilities at the Savannah River Site, including 740 buildings with 511,000 m^2 (5,500,000 ft^2) of floor area. Major nuclear facilities at the Savannah River Site include (or have historically included operation of) fuel and target fabrication facilities, nuclear material production reactors, plutonium storage facilities, chemical separations facilities, a tritium processing area, liquid high-level waste tank farms, a waste vitrification facility, and the Savannah River Technology Center. Nuclear materials are processed into forms suitable for continued safe storage, use, or transportation to other DOE sites. In accordance with the Records of Decision for the *F-Canyon Plutonium Solutions Environmental Impact Statement (60 FR 9824) and the Interim Management of Nuclear Materials Environmental Impact Statement* (60 FR 65300), plutonium solutions have been stabilized and targets have been dissolved and processed in the F-Canyon.

- **DOE Activities—**Current missions at the Savannah River Site are listed in **Table 3–11**. In the past, the Savannah River Site complex produced nuclear materials. The complex consisted of various plutonium storage facilities, five reactors (the C-, K-, L-, P-, and R-reactors, all currently inactive), a fuel and target fabrication plant (currently inactive), two chemical separation plants, a tritium-target processing facility, a heavy water rework facility, and waste management facilities. The K-Reactor (the last operational reactor) has been shut down with no planned provision for restart. The Savannah River Site is still conducting tritium recycling operations for stockpile requirements using retired weapons as the tritium supply source. The separations facilities and the processing facilities are scheduled for use through the year 2003 to complete DOE's commitment to the Defense Nuclear Facilities Safety Board regarding stabilization of site inventories of legacy nuclear materials.

  DOE's Office of Environmental Management is pursuing a 30-year plan to treat, store, and dispose of existing wastes; reduce generation of new wastes; clean up inactive waste sites; remediate contaminated groundwater; and dispose of surplus facilities (DOE 1996a).

  The Savannah River Technology Center provides technical support to DOE's operations at the Savannah River Site. In this role, it provides process engineering development to reduce costs, waste generation, and radiation exposure. The Savannah River Site has an expanding mission to transfer unique technologies developed at the site to industry. In addition, the Savannah River Site is an active participant in the Strategic Environmental Research and Development Program established to develop technologies to mitigate environmental hazards at Department of Defense and DOE sites.

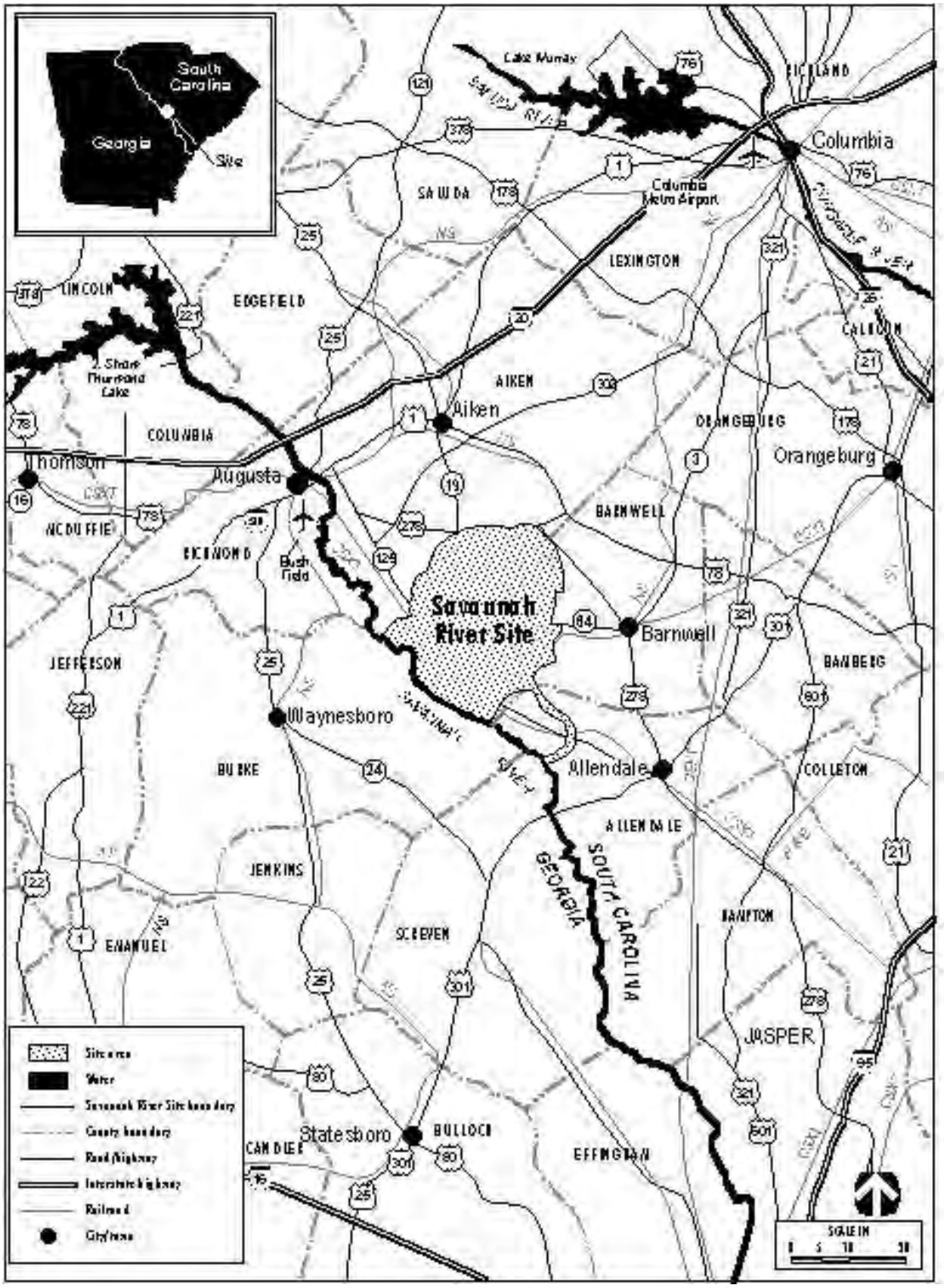


Figure 3–9 Savannah River Site, South Carolina, and Region

Table 3–11 Current Missions at the Savannah River Site

Mission	*Description*
Plutonium storage	Maintain F-Area plutonium storage facilities
Tritium recycling	Operate H-Area tritium facilities
Stabilize targets, spent nuclear fuels, and other nuclear materials	Operate F- and H-Canyons
Waste management	Operate waste processing facilities
Environmental monitoring and restoration	Operate remediation facilities
Research and development	Savannah River Technology Center technical support of Defense Programs, Environmental Management, and Nuclear Energy programs
Other non-DOE missions	Various, as described below, with the U.S. Forest Service, University of Georgia, and University of South Carolina

Source: WSRC 1995.

❒ **Non-DOE Activities—**Non-DOE facilities and operations at the Savannah River Site include the Savannah River Forest Station, the Savannah River Ecology Laboratory, and the Institute of Archaeology and Anthropology. The Savannah River Forest Station is an administrative unit of the U.S. Forest Service, which provides timber management, research support, soil and water protection, wildlife management, secondary roads management, and fire management to DOE. The Savannah River Forest Station manages 62,300 ha (154,000 ac), comprising approximately 80 percent of the site area. It has been responsible for reforestation and manages an active timber business. The Savannah River Forest Station assists with the development and updating of sitewide land use and provides continual support with site layout and vegetative management. It also assists in long-term wildlife management and soil rehabilitation projects.

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

The Institute of Archaeology and Anthropology is operated by the University of South Carolina to survey the archaeological resources of the Savannah River Site. These surveys are used by DOE when planning new facility additions or modifications.

The information in the following subsections is based primarily on the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

3.2.1 Land Resources

❒ **Land Use—**Land use at the Savannah River Site can be grouped into three major categories: forest/ undeveloped, water, and developed facility locations. Forest/undeveloped lands (e.g., open fields and pine or hardwood forests) make up approximately 58,500 ha (144,500 ac) or nearly 73 percent of the total land within the site boundary; water (e.g., wetlands, streams, and lakes) comprises approximately 17,600 ha (43,500 ac) or 22 percent of the site area; and developed facility (e.g., production and support areas, roads, and utility corridors) accounts for approximately 4,000 ha (9,900 ac) or 5 percent of the total land area of the Savannah River Site. Land use bordering the Savannah River Site is primarily forest and agricultural, although there is a substantial amount of open water and nonforested wetland along the Savannah River

Valley. Incorporated and industrial areas are the only other significant land uses in the vicinity. A small amount of urban and residential development borders the Savannah River Site; the nearest residences are located within approximately 60 m (200 ft) of the west, north, and northeast boundaries of the site. Additional information about land resources at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a) and the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995f).

- **Visual Resources—**The Savannah River Site landscape is characterized by wetlands and upland hills. The vegetation is composed of bottom land hardwood forests, scrub oak and pine woodlands, and wetland forests. DOE's facilities are scattered throughout the Savannah River Site and are lit brightly at night. The developed areas and utility corridors (transmission lines and aboveground pipelines) of the Savannah River Site are consistent with a Bureau of Land Management Visual Resource Management Class 5 designation (Class 5 designates areas in which cultural activities so dominate the landscape that natural features are not discernible). In other areas of the Savannah River Site, the natural landscape dominates or the natural landscape features are discernible. Additional information about visual resources can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

3.2.2 Site Infrastructure

- **Baseline Characteristics—**The Savannah River Site contains extensive production, service, and research facilities. Not all of these facilities are in operation today. To support current missions and functions, an extensive infrastructure exists, as shown in **Table 3–12**. The Savannah River Site does not have a connection to the local natural gas lines.

Table 3–12 Savannah River Site Baseline Characteristics

Characteristics	*Current Usage*	*Site Availability*
Transportation		
Roads (km)	230	230
Railroads (km)	103	103
Electrical		
Energy consumption (MWh/yr)	420,000	5,200,000
Peak load (MWe)	70	330
Fuel		
Natural gas (m^3/yr)	0	0
Oil (L/yr)*	15,151,355	N/A
Coal (t/yr)	12,000	N/A
Steam (kg/hr)*	81,818	777,273

MWh/yr = megawatt hours per year MWe = megawatts electric m^3/yr = cubic meters per year L/yr = liters per year
t/yr = tons per year kg/hr = kilograms per hour
Source: DOE 1993b.
*Winter usage only.

The subregional electrical power pool area in which the Savannah River Site is located and from which it draws its power is the Virginia-Carolina Subregion, a part of the Southeastern Electric Reliability Council. The Savannah River Site draws most of its electrical power from coal-fired plants and from 17 nuclear-powered generating plants. Characteristics of this power pool are given in **Table 3–13**.

Table 3–13 Virginia–Carolina Subregional Power Pool Electrical Summary

Characteristics	*Energy Production*
Type Fuel[a]	
Coal	50%
Nuclear	36%
Hydro/geothermal	2%
Oil/gas	3%
Other[b]	8%

[a] Percentages do not total 100 percent because of rounding.
[b] Includes power from nonutility sources only.
Source: NERC 1993.

3.2.3 Air Quality and Noise

❒ **Meteorology and Climatology—**The Savannah River Site has a temperate climate with mild winters and humid summers. Warm, moist maritime air masses affect the climate throughout the year.

- The annual average temperature at the Savannah River Site is 17.8° C (64° F), and monthly averages range from a low of 7.22° C (45° F) in January to a high of 27.2° C (81° F) in July. Average daily relative humidity ranges from a maximum of 90 percent in the morning to a minimum of 43 percent in the afternoon.

- The average annual precipitation at the Savannah River Site is approximately 121.9 cm (48 in) (WSRC 1996). Precipitation distribution is fairly even throughout the year, with the highest precipitation in the summer (36.1 cm [14.2 in]) and the lowest in autumn (22.5 cm [8.8 in]) (Arnett, et. al. 1993). Snowfall has occurred October through March, with an average annual snowfall of 3.0 cm (1.2 in). Large snowfalls are rare (DOE 1995d).

- **Figure 3–10** shows annual wind direction frequencies and wind speeds for the Savannah River Site from 1987 through 1991. Data are from the meteorological tower network at the Savannah River Site. There is no prevailing wind at the Savannah River Site, which is typical for the midlands of South Carolina (WSRC 1996). Maximum frequency of 7.8 percent is from northeast to southwest. The average wind speed for this 5-year period was 3.8 m/s (8.5 mph). Calm winds (less than 2 m/s or 4.5 mph) occurred less than 10 percent of the time during the 5-year period. Seasonally, wind speeds were greatest during the winter, at 4.1 m/s (9.2 mph), and lowest during the summer, at 3.4 m/s (7.6 mph) (Shedrow 1993).

  Winter snowstorms in the Savannah River Site area occasionally bring strong and gusty surface winds with speeds as high as 32 m/s (72 mph). Thunderstorms can generate winds with speeds as high as 18 m/s (40 mph) or even stronger gusts. The fastest wind speed recorded at Augusta between 1950 and 1986 was 37 m/s (83 mph) (DOE 1995d).

  Data collected from the Savannah River Site meteorological monitoring network for 1987-1991 indicate that neutral conditions occur approximately 43 percent, and stable conditions approximately 19 percent on an annual basis.

❒ **Air Quality—**The Savannah River Site is located near the center of the Augusta-Aiken Interstate Air Quality Control Region (#53). The areas within Savannah River and its surrounding counties are in

attainment with respect to the National Ambient Air Quality Standards for criteria pollutants (40 CFR 81.311; 40 CFR 81.341).

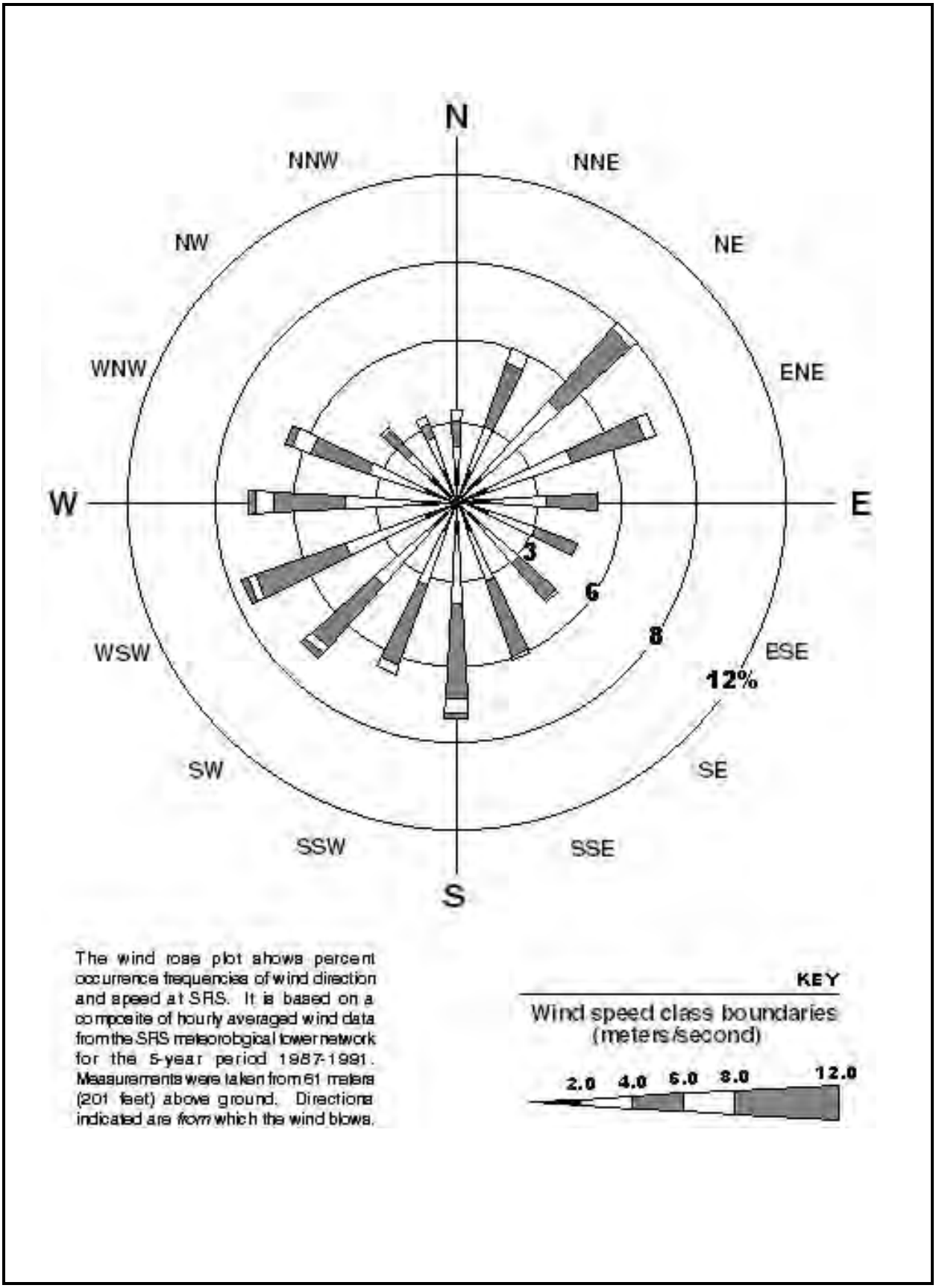


Figure 3–10 Wind Rose for the Savannah River Site (1987–1991)

For locations that are in an attainment area for criteria air pollutants, Prevention of Significant Deterioration regulations limit pollutant emissions from new sources and establish allowable increments of pollutant concentrations. Allowable Prevention of Significant Deterioration increments currently exist for three pollutants (NO_2, SO_2, and PM_{10}). Three Prevention of Significant Deterioration classifications are designated based on criteria established in the Clean Air Act amendments. Class I areas include national wilderness areas, memorial parks larger than 2,020 ha (5,000 acres), and national parks larger than 2,430 ha (6,000 acres). Class II areas include all areas not designated as Class I. No Class III areas have been designated.

There are no Prevention of Significant Deterioration Class I areas within 100 km (62 mi) of the Savannah River Site. The area in which the Savannah River Site is located is classified as a Class II area. None of the facilities at the Savannah River Site has been required to obtain a Prevention of Significant Deterioration permit.

The primary emissions sources of criteria air pollutants at Savannah River Site are the nine coal-burning boilers and four fuel oil-burning package boilers that produce steam and electricity, diesel-engine powered equipment, the Defense Waste Processing Facility, the in-tank precipitation process, groundwater air strippers, and various other process facilities. Other emissions and sources include fugitive particulates from coal piles and coal-processing facilities, vehicles, controlled burning of forestry areas, and temporary emissions from various construction-related activities.

Savannah River Site's contribution to the baseline air concentrations and their applicable standards are included in the data shown in **Table 3–14**. These concentrations are estimates of the highest existing offsite concentrations based on modeling analyses conducted with 1994 emissions data. These concentrations are in compliance with applicable guidelines and regulations (DOE 1998, DOE 1996a).

Ambient air quality monitoring data for 1995 from nearby South Carolina monitors at Beech Island, Jackson, and Barnwell indicate that the National Ambient Air Quality Standards for particulate matter, lead, ozone, sulfur dioxide, and nitrogen dioxide are not exceeded in the area around the Savannah River Site (SCDHEC 1995). Air pollutant measurements at these monitoring locations during 1995 showed for NO_2 an annual average concentration of 9.4 $\mu g/m^3$; for SO_2, concentrations of 99 $\mu g/m^3$ for 3-hour averaging, 24 $\mu g/m^3$ for 24-hour averaging, and 5 $\mu g/m^3$ for the annual average; for total suspended particulates, an annual average concentration of 37 $\mu g/m^3$; and for PM_{10}, concentrations of 62 $\mu g/m^3$ for 24-hour averaging and 19 $\mu g/m^3$ for the annual average.

- **Noise—**The major noise sources at the Savannah River Site are in developed operational areas, including various facilities, equipment, and machines (e.g., cooling towers, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Most major noise sources outside the operational areas are from vehicles and railroad operations. The remote locations of the Savannah River Site operational areas keep existing onsite noise sources from adversely affecting individuals at offsite locations. Noise limits are established for the workplace to protect workers' hearing in accordance with Occupational Health and Safety Administration standards. Existing Savannah River Site–related noise sources of importance to the public are those associated with road and rail traffic. Additional information about noise sources can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

Table 3–14 Comparison of Savannah River Site's Contribution to the Baseline Air Pollutant Concentrations with Most Stringent Applicable Regulations and Guidelines at Savannah River Site, 1994

Pollutant	*Averaging Time*	*Most Stringent Regulation or Guideline*[a] *($\mu g/m^3$)*	*Modeled Concentration*[f] *($\mu g/m^3$)*
Criteria Pollutants			
CO	8-hour	10,000[b]	632
	1-hour	40,000[b]	5000
NO_2	Annual	100[b]	8.8
Ozone	8-hour	157[b]	c
PM_{10}	Annual	50[b]	4.8
	24-hour	150[b]	80.6
$PM_{2.5}$[d]	Annual	15[b]	d
	24-hour	65[b]	d
SO_2	Annual	80[b]	16.3
	24-hour	365[b]	215
	3-hour	1,300[b]	690
Lead	Calendar Quarter	1.5[b]	<0.01
Other Regulated Pollutants			
Hydrogen fluoride	30-day	0.8[e]	0.09
	7-day	1.6[e]	0.39
	24-hour	2.9[e]	1.04
	12-hour	3.7[e]	1.99
Total suspended particulates	Annual	75[e]	43.3
Hazardous and Other Toxic Pollutants[g]			
Nitric acid	24-hour	125.00[e]	50.960
Phosphoric acid	24-hour	25.00[e]	0.462

[a] The more stringent of the Federal and State standards is presented.
[b] Federal standard.
[c] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. EPA recently revised the ambient air quality standards for ozone. The new standards, finalized on July 18, 1997, change the ozone primary and secondary standards from a 1-hour concentration of 235 $\mu g/m^3$ (0.12 ppm) to an 8-hour concentration of 157 $\mu g/m^3$ (0.08 ppm).
[d] EPA recently revised the ambient air quality standards for particulate matter. The current PM_{10} (particulate matter size less than or equal to 10 micrometers) annual standard is retained and two $PM_{2.5}$ (particulate matter size less than or equal to 2.5 micrometers) standards are added. These standards are set at 15 $\mu g/m^3$ (3-year average arithmetic mean based on community-oriented monitors) and 65 $\mu g/m^3$ (3-year average of the 98th percentile of 24-hour concentrations at population-oriented monitors). The current 24-hour PM_{10} standard is revised to be based on the 99th percentile of 24-hour concentrations. Insufficient emissions, modeling and monitoring data exist for estimating concentrations of $PM_{2.5}$.
[e] State standard.
[f] Based on maximum potential emissions for 1994 for all Savannah River Site sources. Gaseous fluorides, nitric acid, and phosphoric acid concentrations based on 1990 emissions, as no 1994 data are available.
[g] Only toxic pollutants emitted from the alternatives being evaluated are presented. The Draft EIS listed additional toxic pollutants which would not be emitted from any of the proposed alternatives and so are not necessary to assess baseline or cumulative air quality impacts.

Source: Adapted from DOE 1998 and DOE 1996a.

3.2.4 Water Resources

❒ **Surface Water—**The Savannah River bounds the Savannah River Site on its southwestern border for about 32 km (20 mi), approximately 260 river km (160 river mi) from the Atlantic Ocean. At the Savannah River Site, the Savannah River flow averages about 283 m^3/s (74,760 gal/s). Five principal tributaries to the Savannah River are found on the Savannah River Site: Upper Three Runs Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek (**Figure 3–11**). These tributaries drain almost all of the Savannah River Site. Each of these streams originates on the Aiken Plateau in the Coastal Plain and descends 15 to 60 m (50 to 200 ft) before flowing into the river. The streams, which

historically have received varying amounts of discharge from the Savannah River Site operations, are not commercial sources of water.

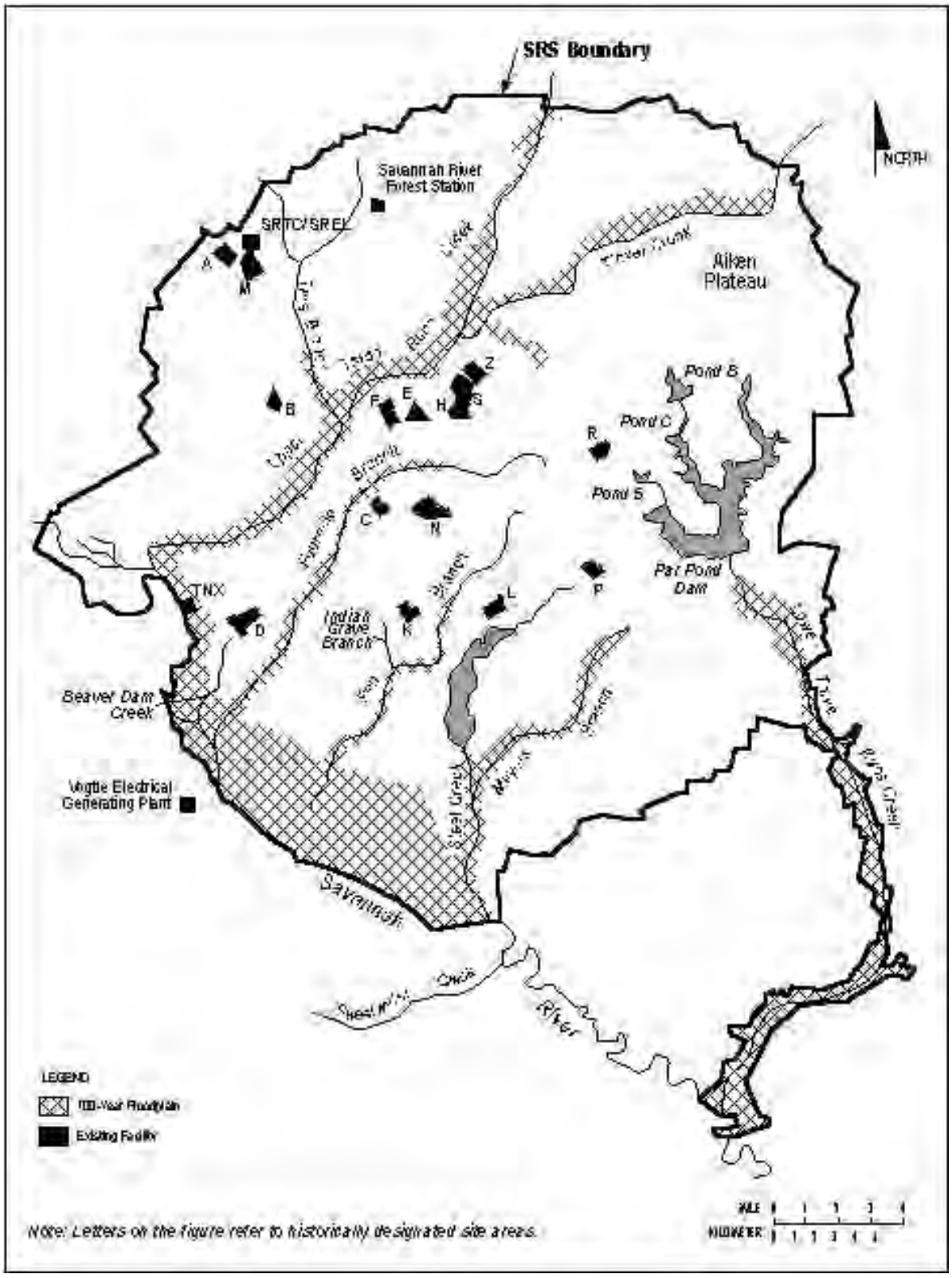


Figure 3–11 The Savannah River Site, Showing 100-Year Floodplain, Major Stream Systems, and Facilities

The natural flow of the Savannah River Site streams ranges from less than 1 m^3/s (264 gal/s) in smaller streams such as Pen Branch to 6.8 m^3/s (1,795 gal/s) in Upper Three Runs. Three large upstream reservoirs—Hartwell, Richard B. Russell, and Strom Thurmond—minimize the effects of droughts and the impacts of low flow on downstream water quality and fish and wildlife resources in the Savannah River.

- *Surface Water Quality*—The Savannah River, which forms the boundary between the States of Georgia and South Carolina, supplies potable water to several areas. Upstream of the Savannah River Site, the river supplies domestic and industrial water needs for Augusta, Georgia and North Augusta, South Carolina. Downstream of the Savannah River Site, the river supplies domestic and industrial water needs for Savannah, Georgia and for Beaufort and Jasper Counties in South Carolina. The South Carolina Department of Health and Environmental Control regulates the physical properties and concentrations of chemicals and metals in the Savannah River Site effluent under the National Pollutant Discharge Elimination System and the chemical and biological water quality standards for Savannah River Site waters. On April 24, 1992, South Carolina Department of Health and Environmental Control changed the classification of the Savannah River and the Savannah River Site streams from "Class B waters" to "Freshwaters." The definitions of Class B waters and Freshwaters are the same, but the Freshwaters classification imposes a more stringent set of water quality standards (Arnett, et. al. 1993). Additional information about surface water quality at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

❒ **Groundwater—**At the Savannah River Site, groundwater in the water table (or most shallow) aquifer flows downward to the Congaree Aquifer or discharges to nearby streams that intersect the water table. Depending on the location at the Savannah River Site, the Congaree Aquifer flows downward to the Cretaceous Aquifer or horizontal to Upper Three Runs Creek or the Savannah River. The Cretaceous Aquifer discharges predominantly along the Savannah River and to upper Three Runs Creek (DOE 1996b).

Most of the rural population in the region draws water from either the Congaree or the water table aquifer. All groundwater at the Savannah River Site is classified by EPA as a Class II water source, meaning it is a current and potential source of drinking water. Groundwater quality ranges from excellent to below EPA drinking water standards for several constituents in the vicinity of some waste sites. For example, the water table aquifer is contaminated with solvents, metals, and low levels of radionuclides at several waste sites and facilities (DOE 1996b).

Groundwater depth ranges from at or very near the ground surface (near streams) to about 46 m (151 ft). Groundwater usage in support of site operations totaled 13,247 million L/yr (3,500 million gal/yr) in 1993 (DOE 1996b). Additional information about groundwater hydrology and quality at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

3.2.5 Geology, Soils, and Seismology

The Savannah River Site is located in the Upper Atlantic Coastal Plain physiographic province of western South Carolina, approximately 32 km (20 mi) southeast of the Fall Line, which separates the Piedmont and Coastal Plain provinces. Sands and sandy loams are the primary types of soil. There is no evidence of recent displacement along any fault within the site (DOE 1991).

The Savannah River Site is located within Seismic Zone 2, indicating moderate earthquake damage could occur. Earthquakes capable of producing structural damage to buildings are not likely to occur in the vicinity of the site. Volcanic activity has not been experienced in the area of the site within the last 230 million years (DOE 1996b).

Areas of seismic activity within a 350-km (200-mi) radius of the Savannah River Site include the Charleston, South Carolina, seismic zone on the coastline of South Carolina and the Bowman, South Carolina, seismic zone east of the site. Known seismic activity within 50 km (30 mi) of the site is located primarily to the east and southeast. Several earthquakes of unknown magnitude/intensity occurred in 1897, and about eight earthquakes have been recorded since the 1970's. The majority of the earthquakes recorded since site operations began have been isolated events of low magnitude (m<3), with no dependent foreshocks or aftershocks detected. The most recent earthquake occurred on August 8, 1993. This quake (M=3.2) had an epicenter located about 40 km (25 mi) northeast of the center of the site and about 12 km (9 mi) northeast of Aiken, South Carolina. The event was not associated with any identified seismic source zones, but instead seemed to be characteristic of widely spread events throughout the central Piedmont and Upper Coastal Plain of the State (WSRC 1995).

3.2.6 Ecology

- **Terrestrial Resources—**At present, more than 90 percent of the Savannah River Site is forested. With the exception of the Savannah River Site production and support areas, natural succession has reclaimed other previously disturbed areas. Satellite imagery of the site shows a circle of wooded habitat within a matrix of cleared uplands and narrow forested riparian corridors. The Savannah River Site provides nearly 73,250 ha (181,000 acres) of contiguous forested cover broken only by unpaved secondary roads, transmission line corridors, and a few paved primary roads. Carolina bays, the Savannah River swamp, and several relatively intact longleaf pine-wiregrass communities make important contributions to the biodiversity of the region.

  The Savannah River Site is near the transition area between the oak-hickory-pine forest and the southern mixed forest. A variety of vascular plant communities occur in the upland areas. Typically, scrub oak communities occur on the drier, sandier areas. Longleaf pine, turkey oak, bluejack oak, blackjack oak, and dwarf post oak dominate these communities, which typically have understories of wire grass and huckleberry. Oak-hickory hardwood communities occur on more fertile, dry uplands, and characteristic species are white oak, post oak, southern red oak, mockernut hickory, pignut hickory, and loblolly pine, with an understory of sparkleberry, holly, greenbriar, and poison ivy (DOE 1995b).

  Savannah River Site has provided excellent habitat to wildlife associated with the wetlands of the Savannah River and the pine-dominated sandhills of coastal South Carolina. Furbearers such as gray fox, raccoon, opossum, and beaver are relatively common throughout the Savannah River Site. Game species such as gray and fox squirrel, cottontail rabbit, and wild turkey are also common. The Savannah River Site contains suitable habitat for white-tailed deer and feral hogs, as well as other faunal species common to the mixed pine/hardwood forests of South Carolina.

- **Wetlands—**The Savannah River Site has extensive, widely distributed wetlands, most of which are associated with floodplain, creeks, and impoundments. The southwestern Savannah River Site boundary adjoins the Savannah River for approximately 32 km (20 mi). The river floodplain supports an extensive swamp, covering about 4,916 ha (12,148 acres) of the site. At present, the swamp forest consists of second-growth bald cypress, black gum, and other hardwood species. Five major streams drain the Savannah River Site and eventually flow into the Savannah River. Each stream has floodplain characterized by bottomland hardwood forests or scrub-shrub wetlands in varying stages of succession.

Dominant species include red maple, box elder, bald cypress, water tupelo, sweetgum, and black willow (DOE 1995b). Carolina bays, unique wetland features of the southeastern United States, are islands of wetland habitat dispersed throughout the uplands of the Savannah River Site. The more than 200 bays on the site exhibit extremely variable hydrology and a range of plant communities from herbaceous marsh to forested wetland.

- **Threatened and Endangered Species—Table 3-15** presents the threatened, endangered, and candidate plant and animal species that are known to occur on the Savannah River Site.

Table 3–15 Federal or South Carolina Endangered or Threatened Plants and Animals Known to Occur on the Savannah River Site

Species	*Status*
Plant	
Echinacea laevigata (smooth purple coneflower)	Federally endangered/2 colonies on Savannah River Site
Animals	
Haliaeetus leucocephalus (bald eagle)	Federally threatened/2 nesting sites on Savannah River Site
Picoides borealis (red-cockaded woodpecker)	Federally endangered/numerous colonies on Savannah River Site
Mycteria americana (wood stork)	Federally endangered/feed in Savannah River Site swamps and reservoirs
Acipenser brevirostrum (shortnose sturgeon)	Federally endangered/eggs and larvae collected from Savannah River adjacent to Savannah River Site
Elanoides forficatus (American swallow-tailed kite)	State endangered/1 sighting reported
Gopherus polyphemus (gopher tortoise)	State endangered/1 reported; habitat on site
Myotis austroriparius (southeastern myotis)	State threatened
Condylura cristata (star-nosed mole)	State endangered
Corynorhinus rafinesquii (southeastern big-eared bat)	State endangered

Source: WSRC 1997c.

The following Federally listed endangered animals are known to occur on the Savannah River Site or in the Savannah River adjacent to the Site: the red-cockaded woodpecker, the southern bald eagle, the wood stork, and the shortnose sturgeon (DOE 1995e). Researchers have found one Federally listed endangered plant species, the smooth coneflower, on the site, and several state listed species (DOE 1995e).

F- and H-Areas contain no habitat suitable for any of the Federally listed threatened or endangered species found on the Savannah River Site. The Southern bald eagle and the wood stork feed and nest near wetlands, streams, and reservoirs, and thus would not be attracted to the densely forested upland area. Shortnose sturgeon, typically residents of large coastal rivers and estuaries, have never been collected in Fourmile Branch or any of the tributaries of the Savannah River that drain the Savannah River Site.

3.2.7 Cultural and Paleontological Resources

Prehistoric resources at Savannah River Site consist of villages, base camps, limited activity sites, quarries, and workshops. Historic sites include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, commercial building locations, and roads. Approximately 400 historic sites or sites with historic components have been identified within the Savannah River Site. Native American groups with traditional ties to the area include the

Apalachee, Cherokee, Chickasaw, Creek, Shawnee, Westo, and Yuchi. Paleontological materials at the Savannah River Site include fossil plants, numerous invertebrate fossils, deposits of giant oysters (*Crassostrea gigantissima*), mollusks, and bryozoa. Additional information about cultural and paleontological resources at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a).

3.2.8 Socioeconomics

- **Regional Economy Characteristics—**The Savannah River Site region of influence includes Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina and Columbia and Richmond Counties in Georgia. Between 1980 and 1990, total employment in the region of influence increased from 139,504 to 199,161, an average annual growth rate of approximately 5 percent. By the year 2000, employment levels should increase 27 percent to approximately 253,000. The unemployment rates for 1980 and 1990 were 7.3 percent and 4.7 percent, respectively (DOE 1995d).

  In Fiscal Year 1992, employment at the Savannah River Site totaled 23,351, with an associated payroll of more than $1.1 billion. In 1990, 75.3 percent of the region of influence labor force lived in Richmond and Aiken Counties, South Carolina (DOE 1995d). The Savannah River Site employed 16,562 people in 1996, accounting for about 7 percent of the regional economic area employment (Section 4.20.4).

- **Population and Housing—**Between 1980 and 1990, population in the region of influence increased 13 percent, from 376,058 to 425,607. More than 88 percent of the 1990 population lived in Aiken (28.4 percent), Columbia (15.5 percent), and Richmond (44.6 percent) Counties. According to 1990 census data, the estimated average number of persons per household in the six-county region was 2.72, and the median age of the population was 31.2 years (DOE 1995d). **Figure 3–12** shows the racial and ethnic composition of minorities residing within an 80-km (50-mi) radius of Savannah River Site at the time of the 1990 census. This 80-km (50-mi) radius defines the region of potential influence for radiological effects evaluated in Chapter 4 of this EIS.

  The minority population as a percentage of total population residing in the region of influence at that time is 13 percent more than the national percentage of minorities (24.2 percent) residing in the continental United States at the time of the 1990 census. Blacks comprised nearly 94 percent of the minority population residing in the region of influence. As illustrated in **Figure 3–13**, the percentage of minority residents equaled or exceeded the national percentage in areas throughout the region of influence.

  As shown in Table F–3 of Appendix F, approximately 17 percent of the individuals residing within the region of influence had a self-reported income less than the poverty level. As discussed in Appendix F, the poverty level is a function of family size and number of unmarried children in the family under 18 years of age. The national percentage of individuals with income less than the poverty level in 1995 is estimated by the Census Bureau to be 13.8 percent. The national percentage of individuals residing in the United States with income below the poverty level was 13.3 percent at the time of the 1990 census. **Figure 3–14** shows the distribution of poverty-level individuals residing within the region of influence.

- **Local Transportation—**The Savannah River Site is surrounded by a system of interstate highways, U.S. highways, State highways, and railroads. The regional transportation networks service the four South Carolina counties (Aiken, Allendale, Bamberg, and Barnwell) and the two Georgia counties (Columbia and Richmond) that generate about 90 percent of the Savannah River Site commuter traffic (DOE 1995f). Two major railroads—CSX Transportation and Norfolk Southern Corporation—also serve the Savannah

River Site vicinity. Norfolk Southern serves Augusta and Savannah, Georgia, as well as Columbia and Charleston, South Carolina. CSX serves the same locations and the Savannah River Site.

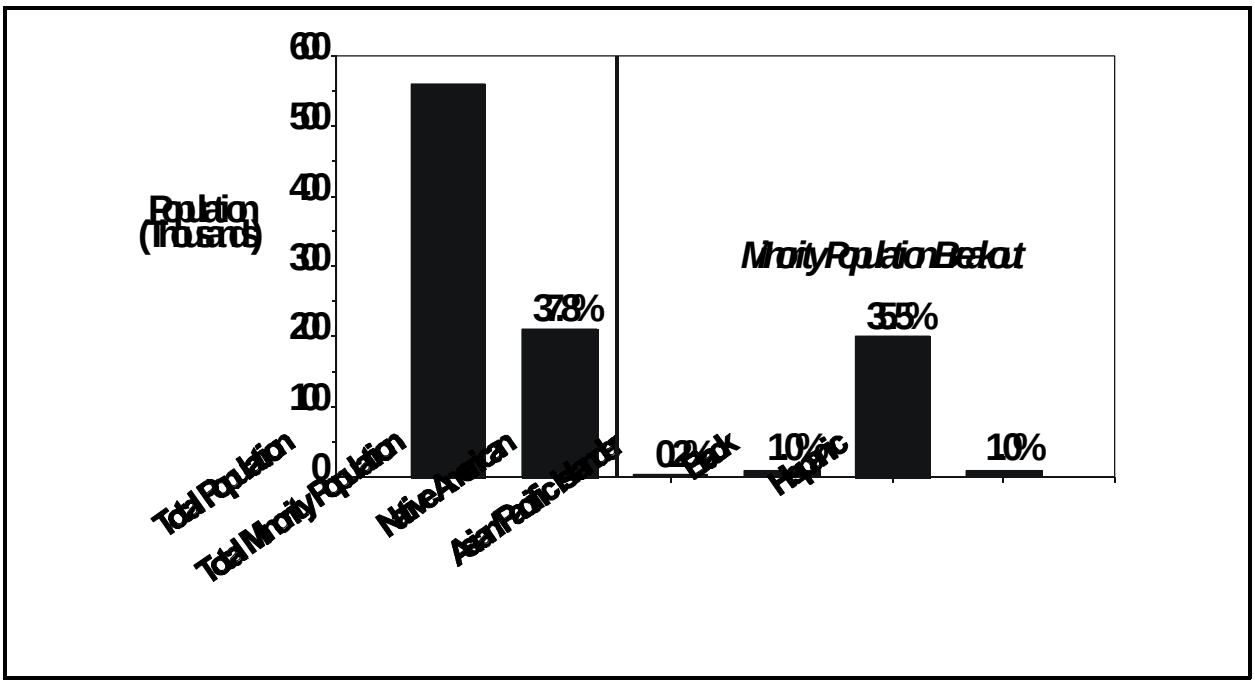


Figure 3–12 Racial and Ethnic Composition of the Minority Population Residing Within 80 km (50 mi) of the Savannah River Site

Two interstate highways serve the Savannah River Site area. Interstate 20 (I-20) provides a primary east-west corridor and I-520 links I-20 with Augusta, Georgia. U.S. Highways 1 and 25 are principal north-south routes, and U.S. 78 provides east-west connections. Several other highways (U.S. 221, U.S. 301, U.S. 321, and U.S. 601) provide additional transport routes in the region. Several State routes provide direct access to the Savannah River Site. From the northwest and north, access is provided by SC 125 and SC 19, respectively, and SC 125 is open to through traffic. Access to the site is provided from the northeast by SC 39, from the east by SC 64, and from the southeast by SC 125. These are all two-lane roads. The public has access to U.S. 278 and SC 125, but only the Savannah River Site employees are permitted access to the site on the other routes.

The Savannah River Site transportation infrastructure consists of more than 230 km (143 mi) of primary roads, 1,931 km (1,200 mi) of unpaved secondary roads, and 103 km (64 mi) of railroad track (DOE 1995b). These roads and railroads provide connections among the various Savannah River Site facilities and offsite transportation linkages.

Two major public highways traverse the Savannah River Site—SC 125 and U.S. 278. SC 125 connects Allendale, South Carolina, to Augusta, Georgia, by crossing the site in a northwest-to-southeast direction. U.S. 278 also connects Augusta and Allendale, but its route generally follows the northern and eastern Savannah River Site boundaries. In general, the primary Savannah River Site roadways are in good condition and are smooth and free from potholes. Typically, wide, firm shoulders border roads that are either straight or have wide gradual turns. Intersections are well marked for both traffic and safety identification, and are sufficiently cleared of trees and brush that might obstruct a driver's view of

oncoming traffic. Railings along the side of the roadways offer protection at appropriate locations from dropoffs or other hazards. In general, the roadways are lighted only at gate areas and near major facilities.

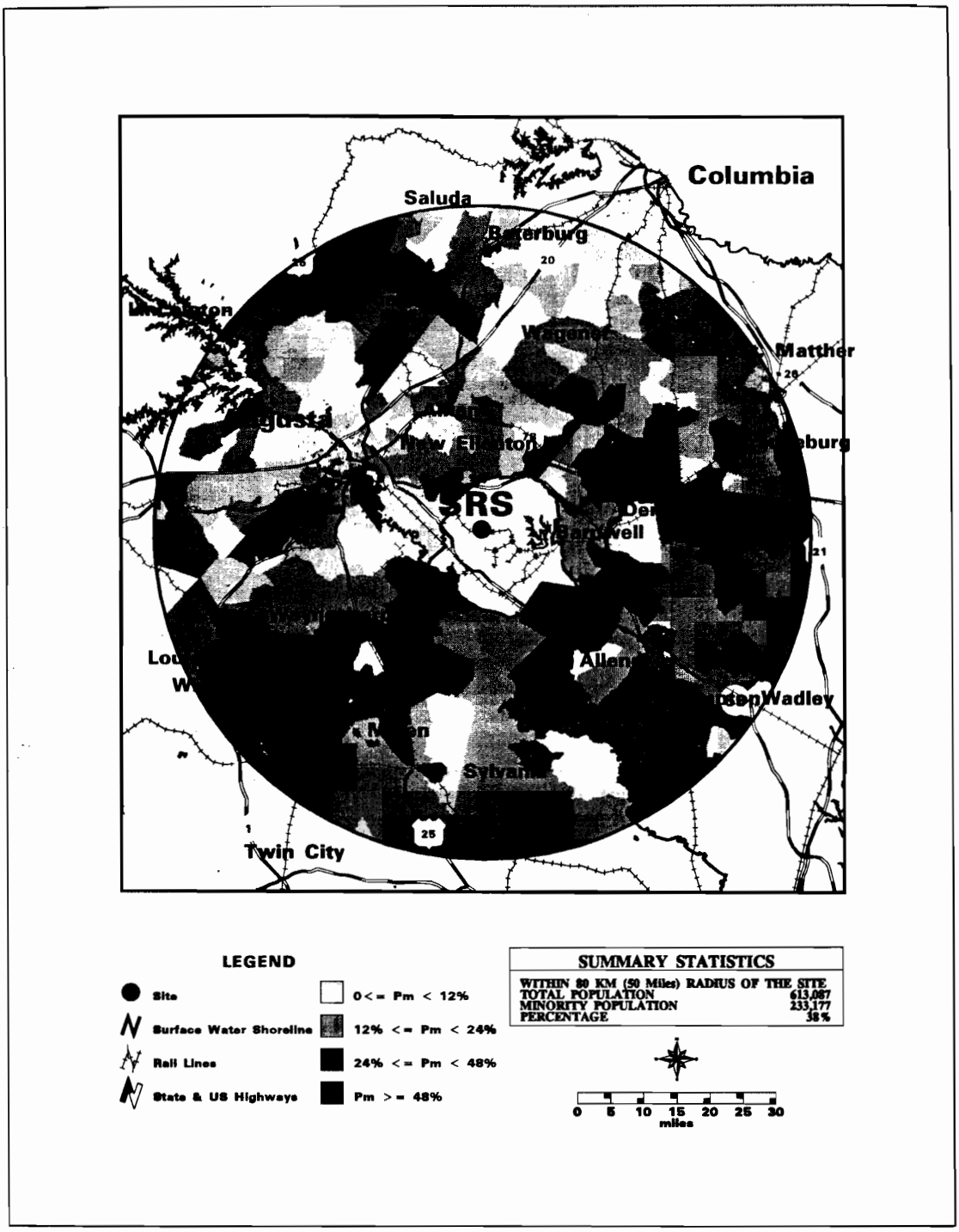


Figure 3–13 Distribution of Minority Population Residing Within 80 km (50 mi) of the Savannah River Site

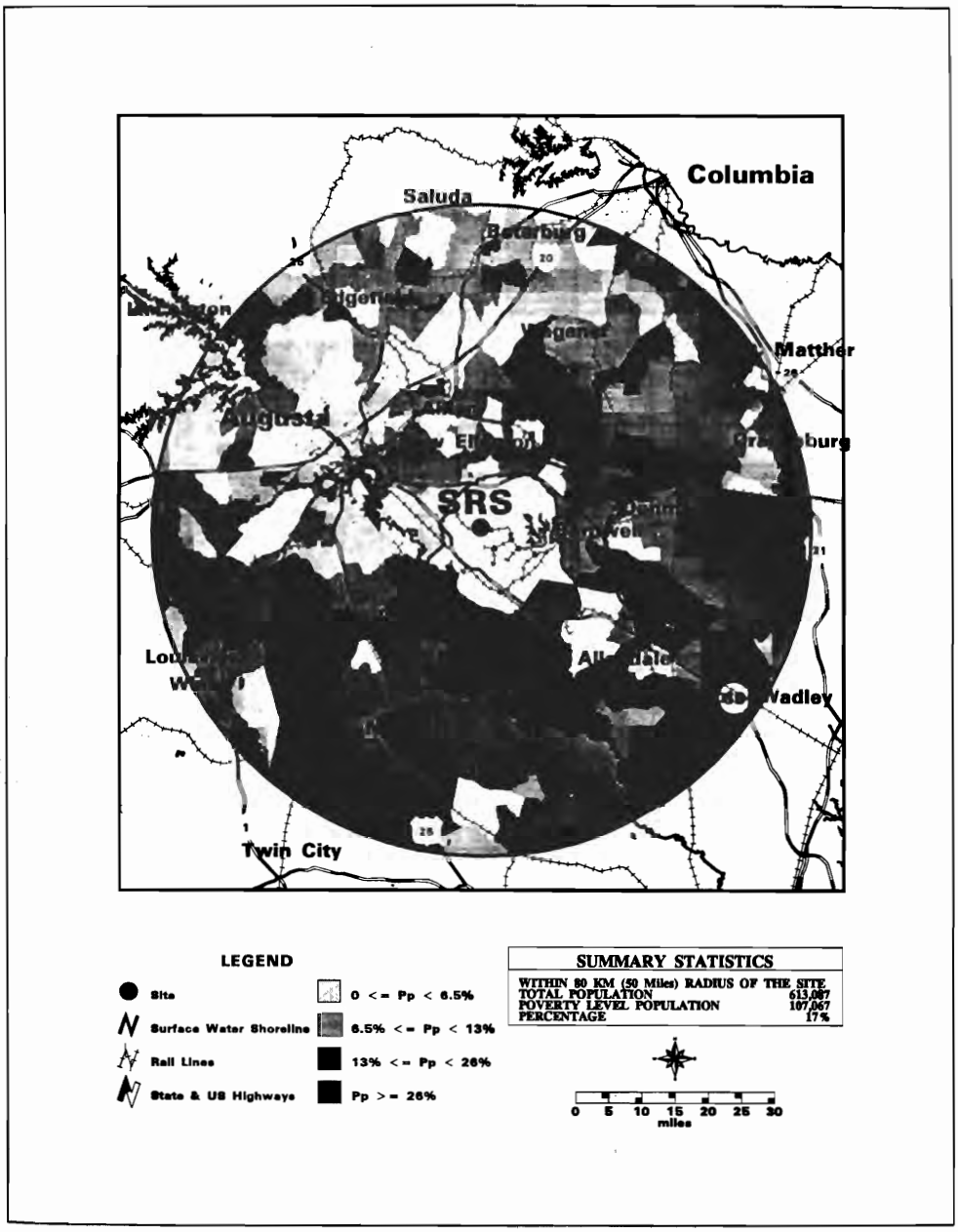


Figure 3–14 Distribution of Poverty-Level Population Residing Within 80 km (50 mi) of the Savannah River Site

In general, heavy traffic occurs early in the morning and late in the afternoon when workers from surrounding communities commute to and from the Savannah River Site. During working hours, official vehicles and logging trucks constitute most of the traffic. At any time, as many as 60 logging trucks, which can impede traffic, might be operating on the Savannah River Site, with an annual average of about 25 trucks per day. **Table 3–16** provides data on traffic counts for various roads and access points around the Savannah River Site (DOE 1995f).

Table 3–16 Savannah River Site Traffic Counts—Major Roads

Measurement Point	*Date*	*Direction*	*Day Total*	*Peak*[a]	*Peak Time*[b]	*Average Speed (mph)*[c]
Road 2 between Roads C and D	2-23-93 4-21-93	East West	3,031 3,075	800 864	1530 0630	47 DNA
Road 4 between Roads E and C	12-9-92 12-9-92	East West	1,624 1,553	352 306	1530 0615	DNA DNA
Road 8 at Pond C	2-23-92 2-23-92	East West	634 662	274 331	1530 0615	58 56
Road C between landfill and Road 2	12-16-92 12-16-92	North South	6,931 6,873	2,435 2,701	1530 0630	53 58
Road C north of Road 7	1-20-93 1-20-93	North South	742 763	288 223	0630 1530	53 54
Road D	9-29-93 9-29-93	North South	1,779 1,813	218 220	1500 0845	43 52
Road E at E-Area	8-25-93 8-25-93	North South	3,099 3,054	669 804	1530 0630	35 38
Road F at Upper Three Runs Creek	2-2-93 2-2-93	North South	3,239 3,192	1,438 1,483	1530 0630	53 51
H-Area Exit	12-2-92	Outbound	2,181	406	1530	12

DNA = data not available mph = miles per hour
[a] Number of vehicles in peak hour.
[b] Start of peak hour.
[c] To convert miles per hour to kilometers per hour, multiply by 1.6093.
Source: Swygert (DOE 1995f).

Railroads on the Savannah River Site include both CSX tracks and the Savannah River Site rolling stock and tracks. Two routes of the CSX distribution system run through the Savannah River Site: a line between Florence, South Carolina and Augusta, Georgia, and a line between Yemassee, South Carolina and Augusta. The two lines join on the site near the L-Lake dam. Early in 1989, CSX discontinued service on the line from the Savannah River Site junction to Florence. The 103 km (64 mi) of the Savannah River Site railroad tracks are well maintained. The rails and crosslines are in good condition, and the track lines are clear of vegetation and debris. Significant clear areas border the tracks on both sides. Intersections of railroads and roadways are marked by railroad crossing signs with lights where appropriate. The Savannah River Site rail classification yard is east of P-Reactor. This eight-track facility sorts and redirects railcars. Deliveries of the Savannah River Site shipments occur at two onsite rail stations at the former towns of Ellenton and Dunbarton. From these stations, a Savannah River Site engine moves the railcars to the appropriate receiving facility. The Ellenton station, which is on the main Augusta-Yemassee line, is the preferred delivery point. The Dunbarton station, which is on the discontinued portion of the Augusta-Florence line, receives less use.

3.2.9 Public and Occupational Health and Safety

❒ **Radiation Environment—**Major sources and levels of background radiation exposure to individuals in the vicinity of the Savannah River Site are shown in **Table 3–17**. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to Savannah River Site operations.

Table 3–17 Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Savannah River Site Operations

Source	*Effective Dose Equivalent (mrem/yr)*
Natural Background Radiation[a]	
Cosmic radiation	27
External radiation	28
Internal terrestrial radiation	40
Radon in homes (inhaled)[b]	200
Other Background Radiation[c]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	360

[a] WSRC 1997a.
[b] Value for radon is an average for the United States.
[c] NCRP 1987.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Savannah River Site Environmental Report* for 1996 (WSRC 1997a). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in this reference.

Releases of radionuclides to the environment from Savannah River Site operations provide another source of radiation exposure to individuals in the vicinity of the Savannah River Site. Types and quantities of radionuclides released from Savannah River Site operations in 1996 are listed in the *Savannah River Site Environmental Report* for 1996 (WSRC 1997a). Doses to the public resulting from these releases are presented in **Table 3–18**. These doses fall within the radiological limits described in DOE Order 5400.5 and are less than dose levels from background radiation.

The Savannah River Site workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in the Savannah River Site facilities. **Table 3–19** presents the average worker and worker population dose to Savannah River Site workers from operations in 1996. These doses fall within radiological regulatory limits (10 CFR Part 835).

Table 3–18 Radiation Doses to the Public from Normal Savannah River Site Operations in 1995 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard [a]	Actual	Standard [a]	Actual [b]	Standard [a]	Actual
Maximally exposed individual (mrem)	10	0.06	4	0.14	100	0.20
Population within 80 km (50 mi)[c] (person-rem)	None	6.4	None	2.2	None[d]	8.6
Average individual within 80 km (50 mi)[e] (mrem)	None	0.010	None	0.0032	None	0.014

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that Order, the 10 mrem/yr limit from airborne emissions is required by the Clean Air Act, the 4 mrem/yr limit is required by the Safe Drinking Water Act, and the total dose of 100 mrem/yr is the limit from all pathways combined.

[b] The actual dose value given in the column under liquid releases conservatively includes all water pathways, not just the drinking water pathway. The population dose includes contributions to Savannah River users downstream of the Savannah River Site to the Atlantic Ocean.

[c] In 1996, this population was approximately 620,100. For liquid releases, an additional 70,000 water users in Port Wentworth, Georgia and Beaufort, South Carolina (approximately 160 km [100 mi] downstream), are included in the assessment.

[d] A 100 person-rem value for the population is given in proposed 10 CFR Part 834 (58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[e] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site for atmospheric releases; for liquid releases, the number of people includes water users who live more than 80 km (50 mi) downstream of the site.

Source: WSRC 1997a.

Table 3–19 Radiation Doses to Workers from Normal Savannah River Site Operations in 1996 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard [a]	Actual
Average worker dose (mrem)	None	19
Total worker population dose[b] (person-rem)	None	237

[a] DOE's goal is to keep radiological exposures as low as reasonably achievable. This includes maintaining doses to individual workers so far below the DOE limit of 5,000 mrem/year (10 CFR Part 835) that no dose is expected to exceed the DOE Administrative Control Level of 2,000 mrem/year (DOE/EH-0256T).

[b] The number of badged workers in 1996 was approximately 12,500.

Source: WSRC 1997b.

❒ **Chemical Environment—**The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., surface waters during swimming and soil through direct contact or via the food pathway).

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and National Pollutant Discharge Elimination System permit requirements) contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at Savannah River Site via inhalation of air containing hazardous chemicals released to the atmosphere by Savannah River Site operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water, or direct exposure, are low relative to the inhalation pathway.

Savannah River Site workers may be exposed to hazardous chemicals during normal operations by inhaling the workplace atmosphere and by direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a detailed estimation and summation of these impacts. However, the workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Savannah River Site workers are also protected by adherence to Occupational Safety and Health Administration and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at the Savannah River Site are expected to be better than required by the standards.

❒ **Emergency Preparedness—**Each of DOE's sites has established an emergency management program that would be used in the event of an accident. These programs have been developed and maintained to ensure an adequate response to accident conditions. The emergency management programs incorporate activities associated with emergency planning, preparedness, and response. The Emergency Operations Facility at the Savannah River Site provides overall direction and control for onsite responses to emergencies and coordinates with Federal, State, and local agencies and officials on the technical aspects of an emergency.

The Savannah River Site Emergency Operations Facility consists of the following centers that provide distinct emergency response support functions:

- *Savannah River Site Operations Center*—The Savannah River Site Operations Center coordinates the initial response to all Savannah River Site emergencies and functions as the heart of the Savannah River Site's emergency response communications network.

- *Technical Support Center*—The Technical Support Center provides command and control of emergency response activities for the affected facility or operational area.

- *Emergency Operations Center*—The Emergency Operations Center provides command and control of emergency response activities for Savannah River Site locations outside the affected area.

- *Security Management Center*—The Security Management Center coordinates activities relating to the security and safeguarding of materials by providing security staff in the affected area and contractor management in the Emergency Operations Center.

- *Dose Assessment Center*—The Dose Assessment Center assesses the health and environmental consequences of any airborne or aqueous releases of radioactivity or toxic chemicals and recommends onsite and offsite protective actions to other centers.

3.2.10 Waste Management

This section outlines the major environmental regulatory structure and ongoing waste management activities for the Savannah River Site. **Table 3–20** presents an overview of waste management activities at the Savannah River Site for 1993.

Table 3–20 Waste Management Activities at Savannah River Site

Category	*1996 Generation (m^3)*	*Treatment Method*	*Treatment Capacity (m^3/yr)*	*Storage Method*	*Storage Capacity (m^3)*	*Disposal Method*	*Disposal Capacity (m^3)*
High-Level							
Liquid	2,379	Settle, separate, evaporate	53,700[b]	F- & H-Area Tank Farm	133,000[c]	N/A[d]	N/A
Solid	None	Vitrification[e]	None	Air Cooled Shielded Facility	2,286 canisters[f]	None; high-level waste program in the future	N/A
Transuranic							
Liquid	None	N/A	N/A	N/A	N/A	N/A	N/A
Solid	165	None	None	Pads, buildings	14,600[g]	None; WIPP or alternate facility in the future	None
Low-Level							
Liquid	None	Absorption, evaporation, filtration, neutralization, saltstone	503,000[h]	Ponds, tanks - awaiting processing	N/A	N/A	N/A
Solid	5,779	Compaction	3,980[i]	N/A	N/A	Burial vaults and trenches	2,578,000[j]
Mixed Low-Level							
Liquid	444	Stabilization, adsorption, neutralization, precipitation, filtration, ion exchange, evaporation	511,000[k]	RCRA permit Bldgs. E, 600, 700, M-Area Liquid Effluent Treatment Facility	11,500[l]	None	None
Solid	8	None	N/A	RCRA permit Bldg. 600	1,990[m]	None	None

Category	*1996 Generation (m^3)*	*Treatment Method*	*Treatment Capacity (m^3/yr)*	*Storage Method*	*Storage Capacity (m^3)*	*Disposal Method*	*Disposal Capacity (m^3)*
Hazardous							
Liquid	None	None	None	DOT containers	Included in solid	Offsite	N/A
Solid	57 (tonnes)	None	None	DOT containers	2,618[n]	Offsite	N/A
Nonhazardous (Sanitary)							
Liquid	None	Filter, settle, strip	1,451,000[o]	Flowing ponds	N/A	Permitted discharge	Varies by each permitted outfall
Solid	2,780 (tonnes)	Compaction	Expandable, as required	N/A	N/A	Landfill (onsite and offsite)	Expandable, as required

DOT = Department of Transportation
Note: N/A = Not applicable.
[a] Some fuel will be processed in the F- and H-Canyons in accordance with the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995b).
[b] Savannah River Technology Center ion exchange, evaporators.
[c] F- and H-Area Tank Farms.
[d] Treatment removes the high-level constituents (salt and sludge) from the liquids. The salt and sludge are vitrified.
[e] Defense Waste Processing Facility started operation in 1995.
[f] Defense Waste Processing Facility.
[g] Transuranic waste storage pads.
[h] Includes F- and H-Area Effluent Treatment Facility.
[i] Onsite compactors.
[j] Saltstone vaults, E-Area vaults, slit trenches.
[k] Includes F- and H-Area Effluent Treatment Facility, M-Area Effluent Treatment Facility, and Savannah River Technology Center Ion-exchange Treatment.
[l] Hazardous Waste Storage Facility, mixed waste storage buildings, Process Waste Interim Treatment, Defense Waste Processing Facility organic waste storage tank, burial ground storage tank, Savannah River Technology Center mixed waste storage.
[m] Hazardous Waste Storage Facility, mixed waste storage buildings.
[n] Pads and buildings in B-, M-, and N-Areas.
[o] Centralized Sanitary Wastewater Treatment Facility.
Sources: DOE 1996b and DOE 1997a.

DOE is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from past operations at the Savannah River Site. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain both schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones.

The EPA has placed the Savannah River Site on the National Priorities List and has identified approximately 150 potential operable units. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, DOE entered into a Federal Facility Agreement with the EPA and the State of South Carolina, effective January 15, 1993. The agreement provides for cleanup activities at the Savannah River Site under one comprehensive strategy.

The Savannah River Site has an aggressive waste minimization program in progress to improve the operation of existing and planned liquid and solid waste generating, treatment, and storage facilities. An approach to these activities is being developed based on technology and experience from the commercial nuclear industry. This approach has reduced the generation of transuranic waste (48 percent), low-level waste (13 percent), mixed waste (96 percent), and hazardous waste (58 percent) (DOE 1993c). The Savannah River Site generates and manages the following waste categories: high-level, transuranic, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

- **High-Level Waste—**Liquid high-level waste at the Savannah River Site is made up of many waste streams generated during the recovery and purification of transuranic waste products and unburned fissile material from spent reactor fuel elements. These wastes are separated by waste form, radionuclide, and heat content before their transfer to underground storage tanks in the F- and H-Area tank farms. Processes routinely used to treat liquid high-level waste are separation, evaporation, and ion exchange. Evaporation produces a cesium-contaminated condensate. Cesium is removed from the condensate, resulting in a low-level waste stream that is treated in the Effluent Treatment Facility. The remaining high-level waste stream salts are precipitated; some can be decontaminated. The decontaminated salt solution is sent with residues from the Effluent Treatment Facility to the Defense Waste Processing Z-Area Saltstone Facility, where it is mixed with a blend of cement, flyash, and blast furnace slag to form grout. The grout is pumped into disposal vaults where it hardens for permanent disposal as solid low-level waste. The remaining high-level salt and sludge are permanently immobilized as a glass solid cast in stainless steel containers at the Defense Waste Processing Facility Vitrification Plant. The stainless steel containers are decontaminated to the U.S. Department of Transportation standards, welded closed, and temporarily stored onsite for eventual transport to and disposal in a permanent Federal repository. Future high-level waste generation could result from the processing and stabilization of spent fuel for long-term storage as a result of 60 FR 28680 and from remediation or materials recovery activities performed in the F- and H-Canyons.

- **Transuranic Waste—**Under the Federal Facilities Compliance Agreement on the Resource Conservation and Recovery Act Land Disposal Restrictions signed by the EPA and DOE on March 13, 1991, the Savannah River Site is required to prepare transuranic waste for shipment. The Savannah River Site will begin discussions with the South Carolina Department of Health and Environmental Control on alternative treatment options in January 1998 if the Secretary of Energy does not decide to operate WIPP by that time. If a delayed opening date for WIPP is determined, DOE will propose modifications to the *Savannah River Site Treatment Plan* for approval by the State of South Carolina. The status of the WIPP readiness schedule will be included in the updates. Certified transuranic waste is stored on transuranic waste storage pads until it can be shipped to an approved transuranic waste disposal facility. Should additional treatment

be necessary for disposal, the Savannah River Site would develop the appropriate treatment capability. All transuranic waste currently generated is stored in containers on above-ground pads.

The Experimental Transuranic Waste Assay and Certification Facility began operations in 1986 to certify newly generated transuranic waste. It since has been shut down. A new transuranic waste characterization and certification facility is planned that would provide extensive containerized waste processing certification capabilities. This facility is needed to prepare and certify transuranic waste for disposal at WIPP. Waste drums containing transuranic waste that can be certified for shipment to WIPP are placed in temporary storage on concrete pads in E-Area. Buried and stored waste containing concentrations of transuranic waste nuclides between 10 and 100 nanocuries (nCi/g) (referred to as alpha-contaminated low-level waste or alpha waste) is managed in the same way as transuranic waste because its physical and chemical properties are similar and because similar procedures will be used to determine its final disposition. Because all of the transuranic waste placed on the above-ground pads prior to January 1990 is suspected of having hazardous constituents, a Resource Conservation and Recovery Act Part B permit application has been submitted for the transuranic waste storage pads and the Experimental Transuranic Waste Assay Certification Facility. The waste currently is being stored under Resource Conservation and Recovery Act interim status. The transuranic waste expected to be produced as a result of the processing of plutonium residues at the Savannah River Site should not contain any Resource Conservation and Recovery Act constituents). If residues containing such constituents are processed at Savannah River, Resource Conservation and Recovery Act permit applications would be submitted for the preprocessing storage of residues and postprocessing storage of transuranic wastes.

- **Low-Level Waste—**The bulk of liquid low-level waste is aqueous process waste, including effluent cooling water, decontaminated salt solutions, purge water, water from storage basins for irradiated reactor fuel or target elements, distillate from the evaporation of process waste streams, and surface water runoff from areas where there is a potential for radioactive contamination. Liquids are processed to remove and solidify the radioactive constituents and to release the balance of the liquids to permitted discharge points within standards established by the regulatory permit. Solid low-level waste includes operating plant and laboratory waste, contaminated equipment, reactor and reactor-fuel hardware, spent lithium-aluminum targets, and spent de-ionizer resin from reactor coolant treatment. Solid low-level waste is separated by radiation levels into low and intermediate categories. Solid low-level waste that radiates less than 200 mrem/hr at 5 cm (1.97 in) from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem/hr at 5 cm (1.97 in), it is considered intermediate-activity waste. Intermediate-activity tritium waste is intermediate-activity waste with greater than 10 Ci of tritium per container. The disposal mode for solid low-level waste is disposal in earthen trenches and concrete vaults. Saltstone generated in the solidification of decontaminated salts extracted from high-level waste is disposed of as low-level waste in separate vaults. Saltstone is the highest volume of solid low-level waste disposed at the Savannah River Site. Disposal facilities are projected to meet solid low-level waste storage requirements and to include low-level waste from offsite DOE facilities for the next 20 years.

- **Mixed Low-Level Waste—**The Federal Facility Compliance Agreement signed by EPA and DOE on March 13, 1991, addresses Savannah River Site compliance with Resource Conservation and Recovery Act Land Disposal Restrictions pertaining to past, ongoing, and future generation of mixed low-level waste (mostly solvents, dioxin, and California list wastes contaminated with tritium). The Savannah River Site is allowed to continue to operate, generate, and store mixed wastes subject to Land Disposal Restrictions; in return, the Savannah River Site will report to the EPA the characterization of all solid waste streams disposed of in land disposal units at the Savannah River Site and has submitted its waste minimization plan to the EPA for review. Schedules for measures to provide compliance through construction of the

Consolidated Incineration Facility and the Hazardous Waste and Mixed Waste Storage Facility are included in the Federal Facility Compliance Agreement.

The Consolidated Incineration Facility will treat mixed low-level and hazardous waste. The Hazardous Waste and Mixed Waste Disposal Vaults are scheduled to be available in 2002. Mixed waste currently is placed in interim storage in the E-Area Solid Waste Disposal Facility and in two buildings in G-Area. These Resource Conservation and Recovery Act permitted facilities will be used until completion of the Consolidated Incineration Facility and the Hazardous Waste and Mixed Waste Storage Facility. The Federal Facility Compliance Act of 1992 requires DOE facilities storing mixed waste to develop site-specific treatment plans and to submit the plans for approval. The Federal Facility Compliance Act of 1992 formed the basis for the Savannah River Site Proposed Site Treatment Plan.

- **Hazardous Waste—**Lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents are typical hazardous wastes generated at the Savannah River Site. All hazardous wastes are stored onsite in U.S. Department of Transportation-approved containers in three Resource Conservation and Recovery Act-permitted hazardous waste storage buildings and on three interim status storage pads in the B- and N-Areas. Most of the waste is shipped offsite to commercial Resource Conservation and Recovery Act-permitted treatment and disposal facilities using U.S. Department of Transportation-certified transporters. Eight to nine percent of the hazardous waste (organic liquids, sludge, and debris) will be incinerated in the Consolidated Incineration Facility. Hazardous chemicals are stripped from aqueous liquids collected during ground water monitoring in the M-Area Stripper, and the treated wastewater is discharged in accordance with discharge limits appropriate to National Pollutant Discharge Elimination System permits.

- **Nonhazardous Waste—**In 1994, the centralization and upgrading of the sanitary wastewater collection and treatment systems at Savannah River were completed. The program included the replacement of 14 aging treatment facilities (out of 20) scattered across the site with a new 3,975 m^3/day (1.05 million gal/day) central treatment facility and connection of them with a new 29-km (18-mi) primary sanitary collection system. The collection system intercepts wastewater at points prior to discharge into old sanitary wastewater treatment facilities. The new central treatment facility treats sanitary wastewater by the extended aeration activated sludge process utilizing the oxidation ditch method. The treatment facility separates the wastewater into two forms, clarified effluent and sludge. The liquid effluent is further treated by nonchemical methods of ultraviolet light disinfection to meet National Pollutant Discharge Elimination System discharge limitations. The sludge goes through a composting process to reduce volume and pathogen levels to meet proposed land application criteria (40 CFR Part 503). The remaining existing sanitary wastewater treatment facilities are being upgraded as necessary to meet demands by replacing existing chlorination treatment systems with nonchemical ultraviolet light disinfection systems to meet National Pollutant Discharge Elimination System limitations. Savannah River Site-generated municipal solid waste is sent to a permitted offsite disposal facility. DOE is evaluating a proposal to participate in an interagency effort to establish a regional solid waste management center at the Savannah River Site (DOE 1994b, DOE 1995a).

3.3 LOS ALAMOS NATIONAL LABORATORY

Los Alamos National Laboratory was established in 1943 as a nuclear weapons design laboratory and was formerly known as the Los Alamos Scientific Laboratory. Its facilities are located on approximately 11,300 ha (28,000 ac), approximately 40 km (25 mi) northwest of Santa Fe, New Mexico.

Los Alamos National Laboratory is a multidisciplinary research facility engaged in a variety of programs for DOE and other Government agencies. Its primary mission is the nuclear weapons Stockpile Stewardship and Management Program and related emergency response, arms control, and nonproliferation and environmental activities. Los Alamos National Laboratory conducts research and development activities in the basic sciences, mathematics, and computing with applications to these mission areas and to a broad range of programs, including nonnuclear defense; nuclear and nonnuclear energy; atmospheric, space, and geosciences; bioscience and biotechnology; and the environment. **Table 3–22** illustrates current missions at Los Alamos National Laboratory.

Table 3–22 Current Major Missions at Los Alamos National Laboratory

Mission	*Description*
Nuclear Weapons	Stockpile stewardship; production of nuclear and nonnuclear components; pit surveillance; tritium production research and development
Arms Control and Nonproliferation	Intelligence analysis; technology research and development; treaty verification; fissile material control; counterproliferation analysis
Energy Research, Science, and Technology	Neutron science (e.g., at LANSCE); scientific computing; fusion energy; health and environmental research; high energy and nuclear physics; basic energy sciences
Energy Technology	Fossil; nuclear
Environmental	Environmental restoration; waste management and treatment
Non-DOE Missions	Conventional weapons; computing, modeling, and simulation

In regard to nuclear weapons, Los Alamos National Laboratory is responsible for the design of the nuclear explosive package in certain U.S. weapons. Los Alamos National Laboratory maintains research, design, development, testing (including nuclear testing), surveillance, assessment, and certification capabilities in support of the Stockpile Stewardship and Management Program. In addition, since the end of the Cold War, Los Alamos National Laboratory conducts the pit surveillance program and some manufacturing of nuclear and nonnuclear components due to termination of the nuclear weapons mission at the Mound, Pinellas, and Rocky Flats Plants.

3.3.1 Land Resources

- **Land Use—**Los Alamos National Laboratory is located in north-central New Mexico, 97 km (60 mi) north-northeast of Albuquerque, 40 km (25 mi) northwest of Santa Fe, and 32 km (20 mi) southwest of Espanola in Los Alamos and Santa Fe Counties. The associated communities of Los Alamos and White Rock are in Los Alamos County. **Figure 3–15** shows the geographical location of Los Alamos National Laboratory. The 11,300-ha (28,000-ac) Los Alamos National Laboratory site and adjacent communities are situated on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep canyons that run from the Jemez Mountains on the west toward the Rio Grande Valley on the east. Mesa tops range in elevation from approximately 2,400 m (7,800 ft) on the west to about 1,900 m (6,200 ft) on the east (LANL 1994b).

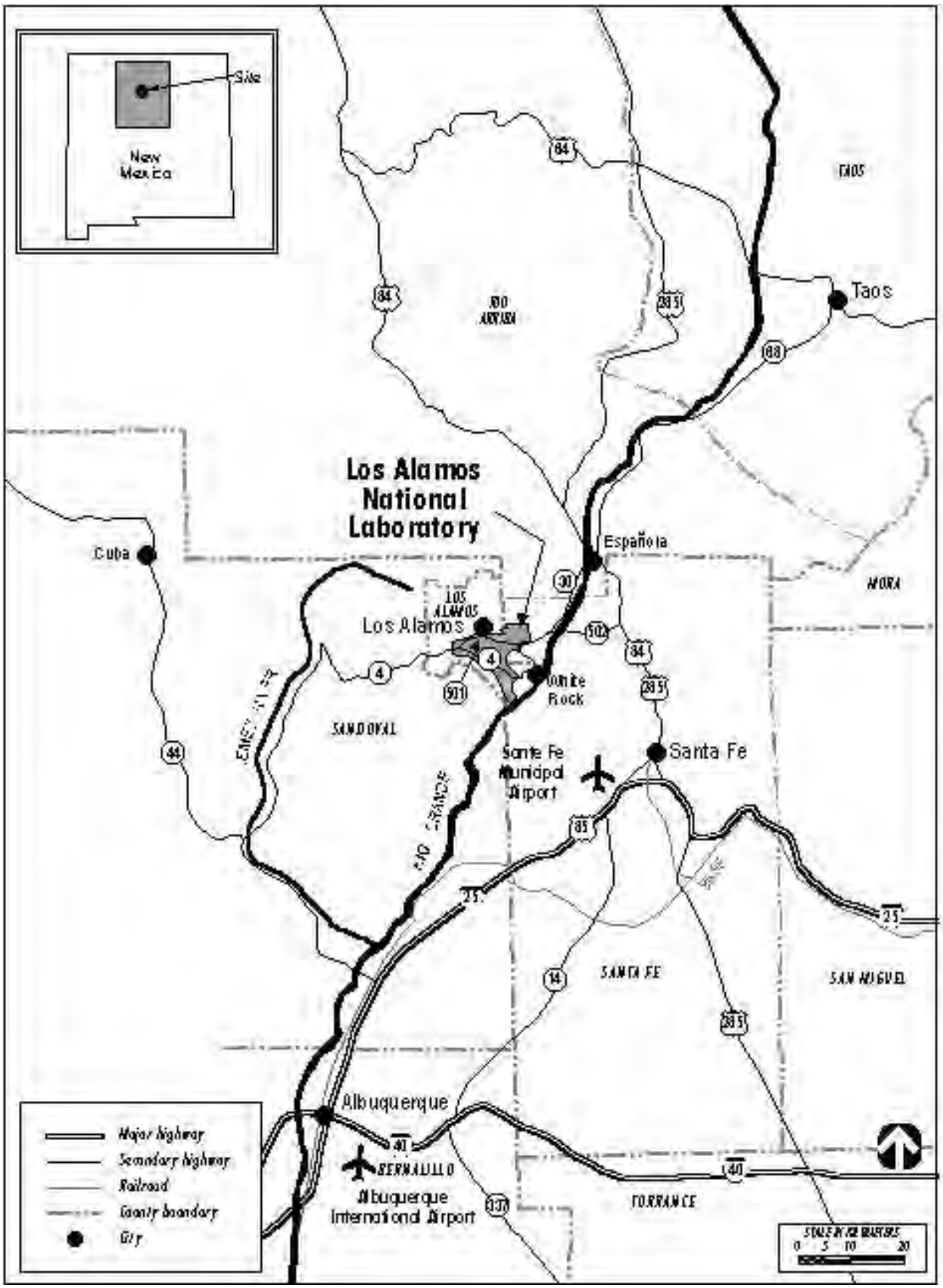


Figure 3–15 Los Alamos National Laboratory, New Mexico, and Region

The developed acreage of Los Alamos National Laboratory consists of 49 active technical areas of laboratory facilities and support infrastructure, which accounts for only a small portion of the total land area. Most of Los Alamos National Laboratory is undeveloped to provide security, safety, and expansion possibilities for future mission requirements. There are no agricultural activities present at Los Alamos National Laboratory, nor are there any prime farmlands. However, a trailer court with a population of approximately 500 persons is located on a parcel of private property that is surrounded by Los Alamos National Laboratory. This court is located along Route 501 in the northern part of Los Alamos National Laboratory (**Figure 3–16**).

The surrounding land is largely undeveloped with large tracts north, west, and south of the Los Alamos National Laboratory site administered by the U.S. Forest Service (Santa Fe National Forest), the National Park Service (Bandelier National Monument), and Los Alamos County. The San Ildefonso Pueblo borders the Los Alamos National Laboratory site to the east (LANL 1994b). The closest offsite residences to Los Alamos National Laboratory, other than those in the trailer park, are approximately 3 m (10 ft) from the northern boundary.

Additional information about land resources at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a) and the *Draft Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (LANL 1998).

3.3.2 Site Infrastructure

❒ **Baseline Characteristics—**Los Alamos National Laboratory contains extensive research and development facilities. To support current missions and functions, an extensive infrastructure exists. Baseline characteristics for this infrastructure are presented in **Table 3–23**.

Table 3–23 Los Alamos National Laboratory Baseline Characteristics

Characteristics	*Current Usage*
Land	
Area (ha)	11,300
Roads (km)	137
Railroads (km)	0
Electrical	
Energy Consumption (MWh/yr)	381,425
Peak Load (MWe)	87
Fuel	
Natural Gas (m^3/yr)	43,414,560
Liquid (L/yr)	0
Coal (t/yr)	0
Steam (kg/hr)	33,554

MWh/yr = megawatt hours per year MWe = megawatts electric m^3/yr = cubic meters per year L/yr = liters per year t/yr = tons per year

Source: Adapted from DOE 1996a.

Locally, Los Alamos National Laboratory is supplied with electricity by a Los Alamos County/DOE power pool. It also has a 20-megawatt electric gas-fired generating plant in Technical Area 3. Electricity is transmitted to the site and the county over two 115-kilovolt lines, one from Santa Fe (Norton Generating Station) and one from Albuquerque (Reeves Generating Station). These lines enter Los Alamos National

Laboratory near Technical Area 5 (Eastern Technical Area substation). Electricity is distributed throughout the site via 13.2-kilovolt lines. The 115-kilovolt system includes a loop that ties substations at Technical

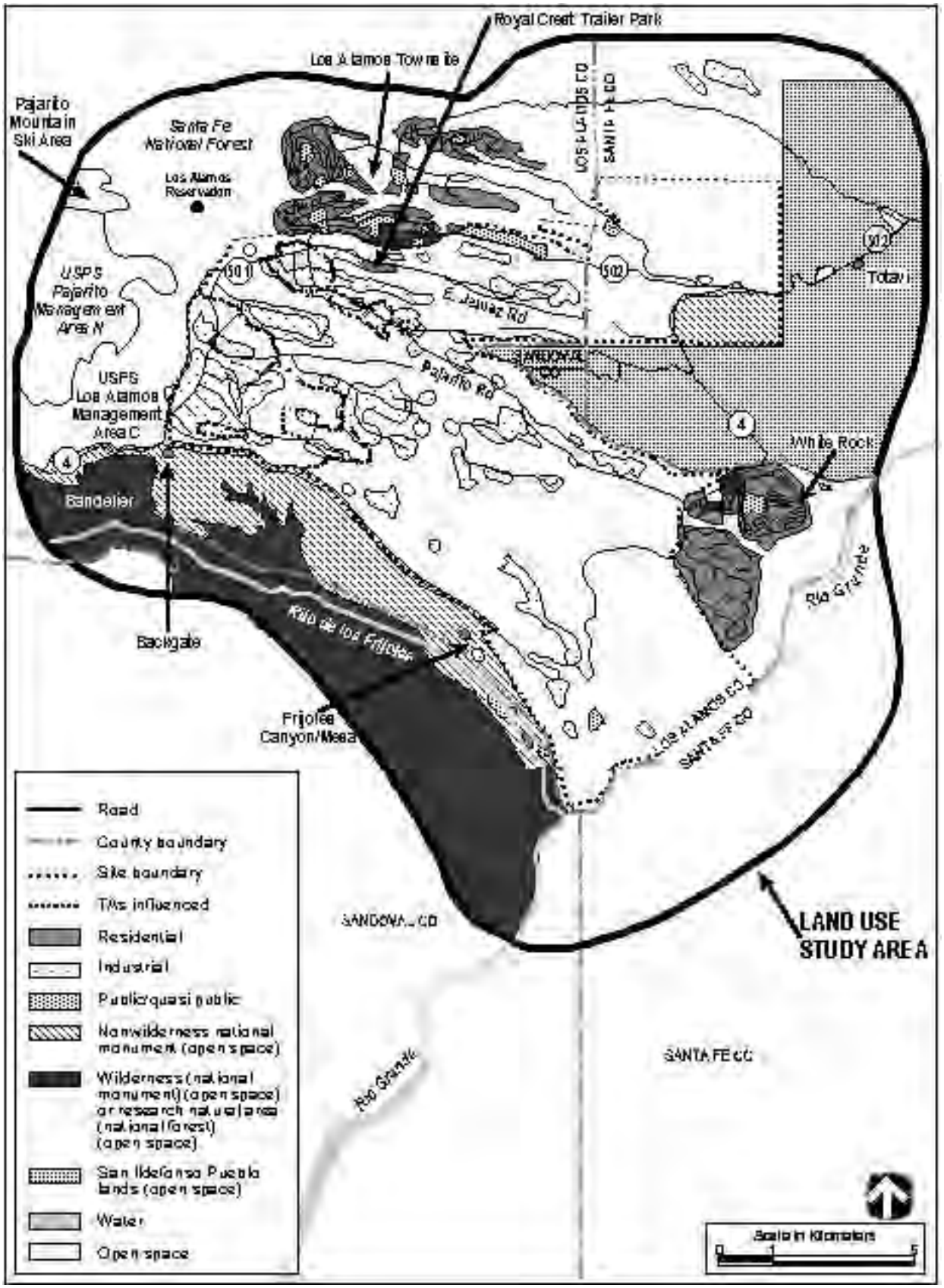


Figure 3–16 Generalized Land Use at Los Alamos National Laboratory and Vicinity

Areas 3, 5, and 53 together. This looping ensures a power supply throughout Los Alamos National Laboratory should outages occur in any major line. The total annual power consumption is considerably below the transmission capacity of the system. The subregional electric power pool from which Los Alamos National Laboratory draws its power is the Arizona-New Mexico Power Area. Capabilities of this power pool are summarized in **Table 3–24.**

Table 3–24 Arizona–New Mexico Subregional Power Pool Electrical Summary

Characteristics	*Energy Production*
Type Fuel[a]	
Coal	57%
Nuclear	24%
Hydro/geothermal	4%
Oil/gas	15%
Other[b]	0.3%

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from both utility and nonutility sources.
Source: Adapted from DOE 1996a.

3.3.3 Air Quality and Noise

❒ **Meteorology and Climatology—**Los Alamos has a semiarid, temperate mountain climate. The climate averages for atmospheric variables such as temperature, moisture, and precipitation are based on observations made at the technical area (TA)-6 Los Alamos National Laboratory weather station from 1961 through 1990. The meteorological conditions described here are representative of conditions on the Pajarito Plateau at an elevation of approximately 2,250 m (7,400 ft) above sea level, including the area in and around TA-55. The average annual temperature at Los Alamos National Laboratory is 8.8°C (47.9°F); temperatures vary from an average daily minimum of -8.3°C (17°F) in January to an average daily maximum of 27.2°C (81°F) in July. The large daily range in temperature of approximately 13°C (23°F) results from the site's relatively high elevation and dry, clear atmosphere, which allows high insolation during the day and rapid radiative losses at night. The average annual precipitation is 47.6 cm (18.7 in), but is quite variable from year to year (LANL 1997).

Los Alamos winds are generally light, averaging 2.8 m/s (6.3 mph). Strong winds are most frequent during the spring when peak gusts often exceed 22 m/s (50 mph). The highest recorded wind gust was 34.4 m/s (77 mph). Because the terrain is complex, heating and cooling rates are uneven over the Los Alamos National Laboratory area, which results in local thermally generated winds (LANL 1994b).

Figure 3–17 shows annual mean windspeed and wind direction frequencies for Los Alamos National Laboratory for 1991. Data are from the Technical Area (TA)-6 meteorological tower, which is the most representative tower data for TA-55. The maximum wind direction frequency is from the south-southwest with secondary maxima from the south and southwest. The mean windspeed toward the north-northeast is 3.2 m/s (7.2 mph). The average annual windspeed is 2.8 m/s (6.3 mph) (DOE 1996a). Data collected at the TA-6 meteorological tower for 1991 indicate that unstable conditions occur approximately 4.5 percent of the time, neutral conditions approximately 21 percent of the time, and stable conditions approximately 34 percent of the time, on an annual basis.

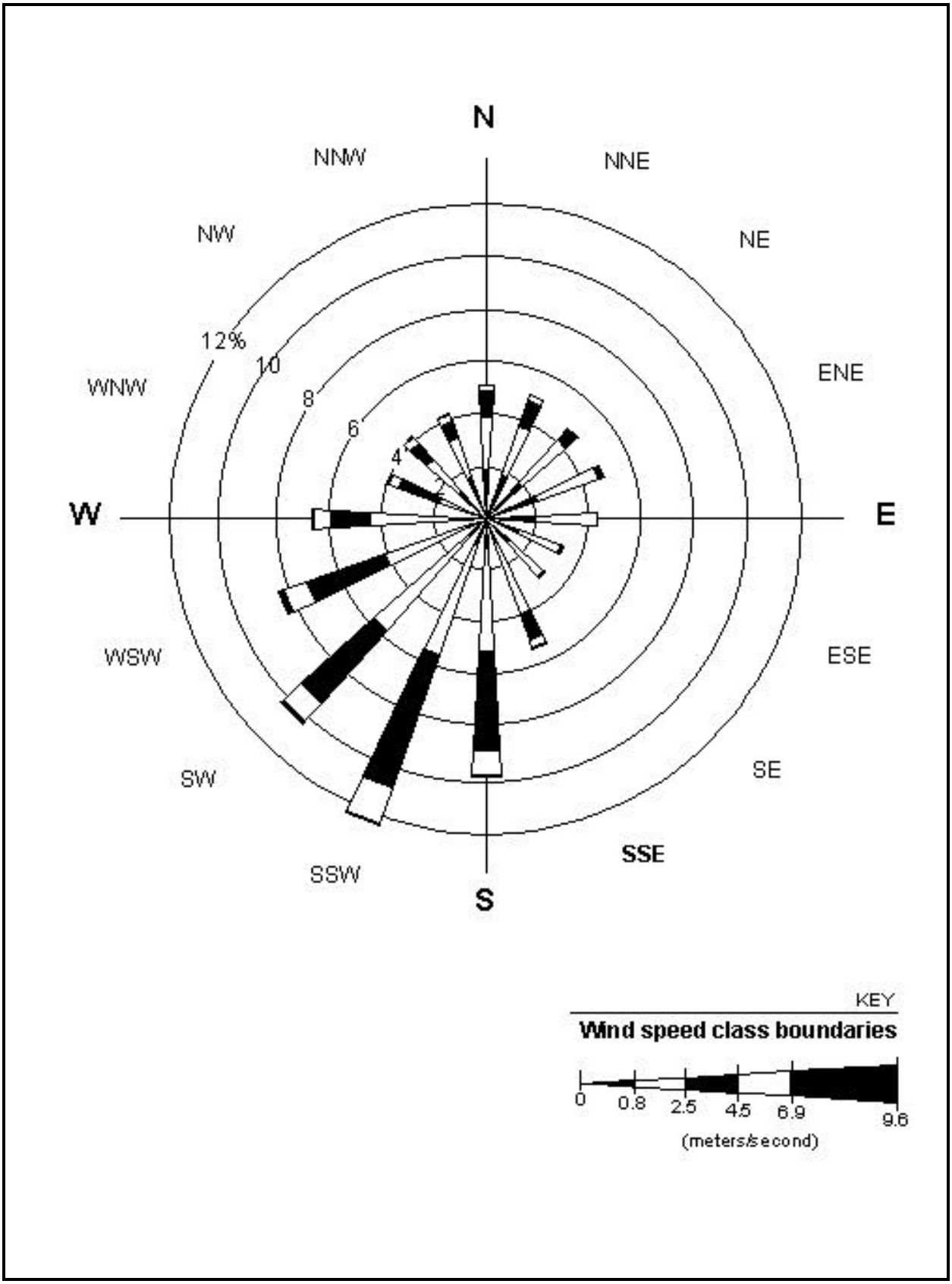


Figure 3–17 Wind Rose for the Los Alamos National Laboratory (1991) (11.5-meter level)

❒ **Air Quality—**Los Alamos National Laboratory is located within the New Mexico Intrastate Air Quality Control Region No. 157. None of the areas within Los Alamos National Laboratory and its surrounding counties are designated as nonattainment areas with respect to any of the National Ambient Air Quality Standards (40 CFR Part 81.332).

For locations that are in an attainment area for criteria air pollutants, Prevention of Significant Deterioration (PSD) regulations limit pollutant emissions from new sources and establish allowable increments of pollutant concentrations. Allowable PSD increments currently exist for three pollutants (NO_2, SO_2, and PM_{10}). Three PSD classifications are designated based on criteria established in the Clean Air Act amendments. Class I areas include national wilderness areas, memorial parks larger than 2,020 ha (5,000 acres), and national parks larger than 2,430 ha (6,000 acres). Class II areas include all areas not designated as Class I. No Class III areas have been designated.

One Prevention of Significant Deterioration Class I Area, the Bandelier National Monument's Wilderness Study Area, borders Los Alamos National Laboratory to the south. Los Alamos National Laboratory has not been subject to Prevention of Significant Deterioration requirements (LANL 1994b).

Table 3-25 presents estimated emission rates for criteria and toxic/hazardous air pollutants at Los Alamos.

Table 3–25 Emission Rates of Criteria and Toxic/Hazardous Air Pollutants at Los Alamos National Laboratory[a]

Pollutant	*Emission Rate (kg/yr)*
Criteria Pollutants	
CO	16,756
NO_2	67,904
PM_{10}	2,731
SO_2	246
Lead	26
Other Regulated Pollutants	
Asbestos	[b]
Beryllium	[b]
Heavy Metals	[b]
Hydrogen Sulfide	[b]
Nonmethane Hydrocarbons	[b]
Photochemical Oxidants	[b]
Total Reduced Sulfur	[b]
Total Suspended Particulates	2,731
Hazardous and Other Toxic Pollutants	(c)

[a] Estimated 1996 emissions for all pollutants except lead. Estimated 1990 emissions for lead; no 1996 data available.
[b] No emissions of this pollutant listed.
[c] No toxic pollutants would be emitted by the proposed processing alternatives. The Draft EIS listed various toxic pollutants which would not be emitted from any of the proposed alternatives and so are not necessary to assess baseline or cumulative air quality impacts.
Source: LANL 1997, DOE 1996a.

These emissions are presented for the purpose of comparison with other sites addressed in this EIS and were not modeled to estimate air pollutant concentrations.

Criteria pollutants—nitrogen dioxide, carbon monoxide, ozone, lead particulate matter, and sulfur dioxide—make up approximately 79 percent of the stationary source emissions at Los Alamos National Laboratory. The source of these criteria pollutants is combustion in power plants, steam plants, asphalt plants, and local space heaters. Toxic and other hazardous pollutants represent the remaining 21 percent of emissions from stationary sources at Los Alamos National Laboratory. These emissions are generated by equipment surface cleaning, coating processes, and acid baths and include gases, vapors, metal dusts, and miscellaneous emissions such as wood dust, hazardous gases, and plastics (LANL 1994b).

Table 3–26 presents the monitored ambient air concentrations for criteria pollutants for 1992 and other pollutants of concern for 1990 at Los Alamos National Laboratory. These concentrations are based on monitoring data from monitors located adjacent to the Bandelier National Monument. These concentrations are in compliance with applicable guidelines and regulations.

Table 3–26 Comparison of Baseline Air Pollutant Concentrations with Most Stringent Applicable Regulations and Guidelines at Los Alamos National Laboratory, 1990 and 1992

Pollutant	*Averaging Time*	*Most Stringent Regulation or Guideline (µg/m³)*	*Monitored Concentration (µg/m³)*
Criteria Pollutants			
CO	8-hour	7,689[a]	115
	1-hour	11,578[b]	630
NO_2	Annual	73[a]	3.8
	24-hour	145[a]	c
Ozone	8-hour	157[b]	d
PM_{10}[e]	Annual	50[b]	8
	24-hour	150[b]	21
$PM_{2.5}$[e]	Annual	15[b]	e
	24-hour	65[b]	e
SO_2	Annual	40[a]	1.3
	24-hour	262[a]	c
	3-hour	1,300[b]	c
Lead	Calendar quarter	1.5[b]	c
Other Regulated Pollutants[g]			
Asbestos	30-day	0.01[a]	c
Beryllium	Calendar quarter	f	0.00002
	30-day	0.01[a]	c
Heavy metals	30-day	10[a]	c
Hydrogen sulfide	1-hour	14[a]	c
Nonmethane hydrocarbons	3-hour	100[a]	c
Photochemical oxidants	1-hour	118[a]	151
Total reduced sulfur	30-minute	3.9[a]	c
Total suspended particulates	Annual	60[a]	8
	30-day	90[a]	<21
	7-day	110[a]	<21
	24-hour	150[a]	21

[a] State standard.
[b] Federal standard.
[c] No monitoring data available; baseline concentrations assumed less than applicable standard.
[d] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. EPA recently revised the ambient air quality standards for ozone. The new standards, finalized on July 18, 1997, change the ozone primary and secondary standards from a 1-hour concentration of 235 µm/m^3 (0.12 ppm) to an 8-hour concentration of 157 µg/m^3 (0.08 ppm).
[e] EPA recently revised the ambient air quality standards for particulate matter. The current PM_{10} (particulate matter size less than or equal to 10 micrometers) annual standard is retained and two $PM_{2.5}$ (particulate matter size less than or equal to 2.5 micrometers) standards are added. These standards are set at 15 µg/m^3 (3-year average arithmetic mean based on community-oriented monitors) and 65 µg/m^3 (3-year average of the 98th percentile of 24-hour concentrations at population-oriented monitors). The current 24-hour PM_{10} standard is revised to be based on the 99th percentile of 24-hour concentrations. Insufficient emissions, modeling, and monitoring data exist for estimating concentrations of $PM_{2.5}$.
[f] No standard.
[g] Mandated by New Mexico.

Source: Adapted from DOE 1996a.

3.3.4 Water Resources

- **Surface Water—**The Rio Grande River is the major surface water feature in north-central New Mexico. All surface water drainage and groundwater discharge from the Pajarito Plateau ultimately arrives at the Rio Grande. The Rio Grande at Otowi, just east of Los Alamos, has a drainage area of 37,037 square kilometers (km^2) (14,300 square miles [mi^2]) in southern Colorado and northern New Mexico (DOE 1995e).

Eleven drainage areas, with a total area of 212 km^2 (82 mi^2) pass through the eastern boundary of Los Alamos National Laboratory. Runoff from heavy thunderstorms and heavy snowmelt reaches the Rio Grande several times a year from some drainages. Los Alamos, Pajarito, and Water Canyons have drainage areas greater than 26 km^2 (10 mi^2). Pueblo Canyon has a drainage area of 21 km^2 (8 mi^2); all others have less than 13 km^2 (5 mi^2). The overall flood risk to Los Alamos National Laboratory is low because nearly all the structures are located on the mesa tops, from which runoff drains rapidly into the deep canyons (DOE 1995e). The hydrological features at Los Alamos National Laboratory are depicted in **Figure 3–18**. No surface water is withdrawn at Los Alamos National Laboratory for either drinking water or facility operations (DOE 1993c).

Existing wastewater generation from Los Alamos National Laboratory is approximately 1,351 million L/yr (357 gal/yr). Permitted effluent discharges at Los Alamos National Laboratory into 10 of the major watersheds from the currently active National Pollutant Discharge Elimination System permitted industrial outfalls (Bradford 1996, DOE 1996c).

Los Alamos National Laboratory has three wastewater treatment facilities: Sanitary Waste Water Systems Consolidation plant, the Radioactive Liquid Waste Treatment Facility, and the High Explosives Wastewater Treatment Facility. Industrial effluent that does not go through these centralized treatment facilities is discharged to the environment through outfalls. The outfalls at Los Alamos National Laboratory are covered by National Pollutant Discharge Elimination System Permit NM0028355. In the National Pollutant Discharge Elimination System Permit, these outfalls are grouped by category according to effluent source type. The National Pollutant Discharge Elimination System Permit contains discharge limitations for each category of outfall based on the physical and chemical characteristics of each wastewater type. Any effluent discharging to a watercourse must also meet the New Mexico Water Quality Control Commission's Standards for Interstate and Intrastate Streams which are promulgated by New Mexico's Environmental Improvement Board and established in the New Mexico Water Quality Act (74-6-1 to 74-6-4, 7-6-6 to

74-6-13, NMSA 1978). The c\urrent designated uses include livestock watering and wildlife habitat. The number of Los Alamos National Laboratory outfalls in use at any given time changes

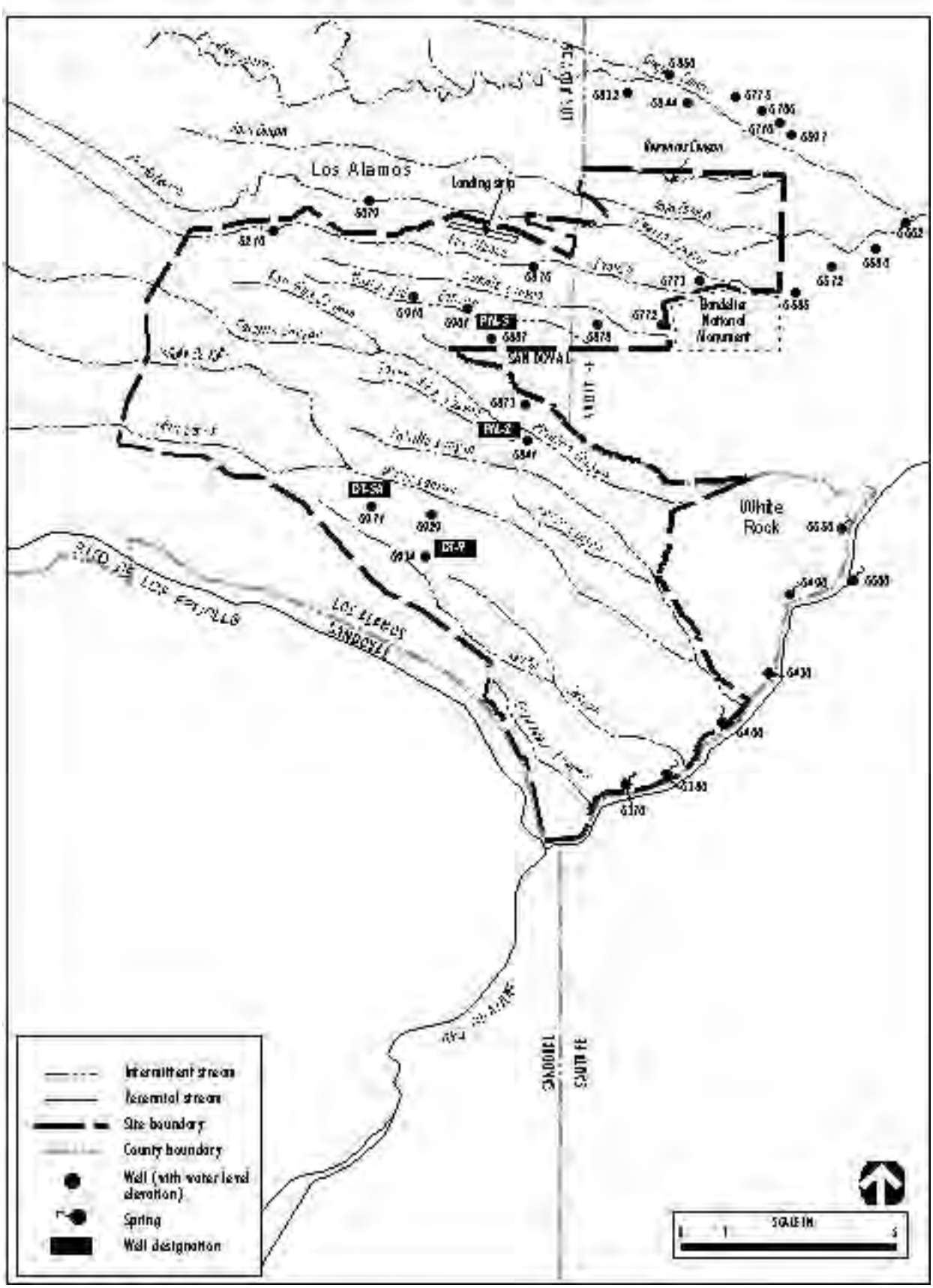


Figure 3–18 Surface Water Features Near Los Alamos National Laboratory

as individual projects, such as research and development projects, are started and completed at various Los Alamos National Laboratory locations (DOE 1996c).

Surface water quality monitoring results indicate that the overall compliance for sanitary and industrial discharges during 1995 was 100 percent and 98 percent, respectively. Additional information about surface water quality at the site can be found in the publication *Environmental Surveillance at Los Alamos During 1995* (LANL 1996).

- *Water Rights and Permits*—Water rights in New Mexico fall under the Doctrine of Prior Appropriations. Under this doctrine, the user who first appropriated water for a beneficial use has priority to use the available water supply over a user claiming rights at a later time. All natural water flowing in streams and water courses in New Mexico is considered to be public and subject to appropriation for beneficial use. Beneficial use is the basis, measure, and limit of the right to use water. No water right, therefore, may be granted or claimed for more than the amount that can be beneficially used. DOE owns combined surface and groundwater rights. These rights include the withdrawal of 5,541.3 acre-ft/yr (approximately 6,835 million L/yr) from a variety of wells and surface diversions under licenses RG–485 through RG–488, 1503, 1802, and 1802–B. DOE also owns a contract for 1,200 acre-ft/yr (1,480 million L/yr) of San Juan/Chama Diversion water.

❒ **Groundwater—**Groundwater in the Los Alamos National Laboratory area exists in three modes—in shallow alluvium in canyons, in perched groundwater, and in the main aquifer. The main aquifer consists mostly of clastic sediments within the Santa Fe Group and the Puye Formation. Nearly all groundwater at Los Alamos National Laboratory is obtained from deep wells that produce water from this aquifer. A minor amount of groundwater at Los Alamos National Laboratory is obtained from springs. Most aquifers that lie beneath Los Alamos National Laboratory, with the exception of perched zones, are considered Class II aquifers, having current sources of drinking water and other beneficial uses (DOE 1993c).

The most productive area lies in the central portion of the Pajarito Plateau and includes the Pajarito well field. The average drawdown for these wells is 12 m (39.4 ft). The rate of movement of water in the aquifer is approximately 12 to 29 m (39.4 to 95.1 ft) per year (DOE 1996a).

- *Groundwater Quality*— Most of the wells in the Pajarito Plateau yield fresh water (total dissolved solids less than 500 mg/l), although some wells east of the site have a higher total dissolved solids content (1,000 mg/L or more). The primary, secondary, and radiochemical groundwater quality, as measured from wells and springs in the main aquifer, were below DOE's derived concentration guides or the New Mexico standards applicable to a DOE drinking water system (DOE 1993c). All parameters were below the applicable water quality criteria or standard in the main aquifer in 1993. Additional information about groundwater quality at the site can be found in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a) and the *Draft Site-wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (LANL 1998).

- *Groundwater Availability and Use*—Los Alamos National Laboratory, the nearby communities of Los Alamos and White Rock, and Bandelier National Monument are entirely dependent on groundwater for their water supply. The water supply is primarily obtained from well fields. During 1993, total production from the wells for potable and nonpotable use was 5,519 million L (1,458 million gal). Los Alamos National Laboratory's water system had an average demand equal to about 81 percent of its

current allotment of 6,800 million L/yr (1,800 million gal/yr). The site's water system and wells supply the Los Alamos townsite, the White Rock Community, and the Bandelier National Monument facilities.

Two new wells have been drilled at Los Alamos National Laboratory, one of which began pumping in the summer of 1992. The new wells are expected to supplant the now abandoned Los Alamos field. Water is taken from depths of 245 to 550 m (804 to 1,805 ft).

Over the next 50 years, increases in water use may require one of the following: use of the 1,500 million L/yr (396 million gal/yr) of San Juan-Chama water (releasing the water in exchange for excess pumping) and/or establishment of credit for return flow (DOE 1993c).

3.3.5 Geology, Soils, and Seismology

- **Geology and Soils—**Los Alamos National Laboratory is located on the Pajarito Plateau. The surface of the plateau is dissected by deep, southeast-trending canyons separated by long, narrow mesas. The Pajarito Plateau is capped by the Bandelier Tuff, a geologic unit comprising a massive pumiceous tuff breccia of ash-flow origin and a succession of cliff-forming welded ash flows. The tuff is underlain by sedimentary and volcanic rocks of the Santa Fe Group (DOE 1979).

The site is underlain by soil types varying in texture from clay and clay loam to gravel. More than 95 percent of the soils are developed on acidic volcanic rocks. Because of the topographic relief of the Pajarito Plateau, rock outcrops occur on more than 50 percent of the site area. The soils are acceptable for standard construction techniques. No soils in Los Alamos County have been designated prime farmland or Soil of Statewide Importance for New Mexico (DOE 1996a).

Detailed information about site geology and soils can be found in the *Draft Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (LANL 1998).

- **Seismology—**Los Alamos National Laboratory lies within seismic Zone 2. The strongest earthquake in the last 100 years within an 80-km (50-mi) radius was estimated to have a magnitude of 5.5 to 6 and a modified Mercalli intensity of VII. Studies suggest that several faults have produced seismic events with a magnitude of 6.5 to 7.8 in the last 500,000 years. Los Alamos National Laboratory operates a seismic hazards program that monitors seismicity through a seismic network and conducts studies in paleoseismology. Major faults at Los Alamos National Laboratory include the Pajarito, Rendija Canyon, and Guaje Mountain faults (**Figure 3–19**). Specific details regarding these faults are shown in **Table 3-27**. As presented in the table, the Guaje Mountain fault last moved between 4,000 and 6,000 years ago. There is no evidence of movement along the Pajarito fault system during historical times (DOE 1995e). It is believed that the Rendija Canyon Fault (which is closest to TA-55) last moved between 8,000 and 9,000 years ago (LANL 1998). The 100-year earthquake at Los Alamos is regarded as having a magnitude of 5, with an event of magnitude 7 being the maximum credible earthquake (DOE 1979). These values are currently used in design considerations at Los Alamos National Laboratory. In 1996 through 1997, LANL geologists conducted detailed geologic mapping studies in and around TA-55 and geologic trenching studies on the Pajarito Fault. Results from these studies are currently under review (LANL 1998). Geological concerns associated with the Los Alamos National Laboratory area include potential downslope movements in association with regional seismic activity. Although isolated rockfalls commonly occur from the canyon rims, landslides are an unlikely hazard at Los Alamos because of the dry climate, the deep water table, and the rock characteristics. Although the area has the potential for future volcanic eruptions, the periodicity and structural development of past eruptions indicate a low

probability of an eruption occurring within the next 1,000 years (DOE 1979). Additional details can be found in Appendix D, Section D 3.3.3.3.

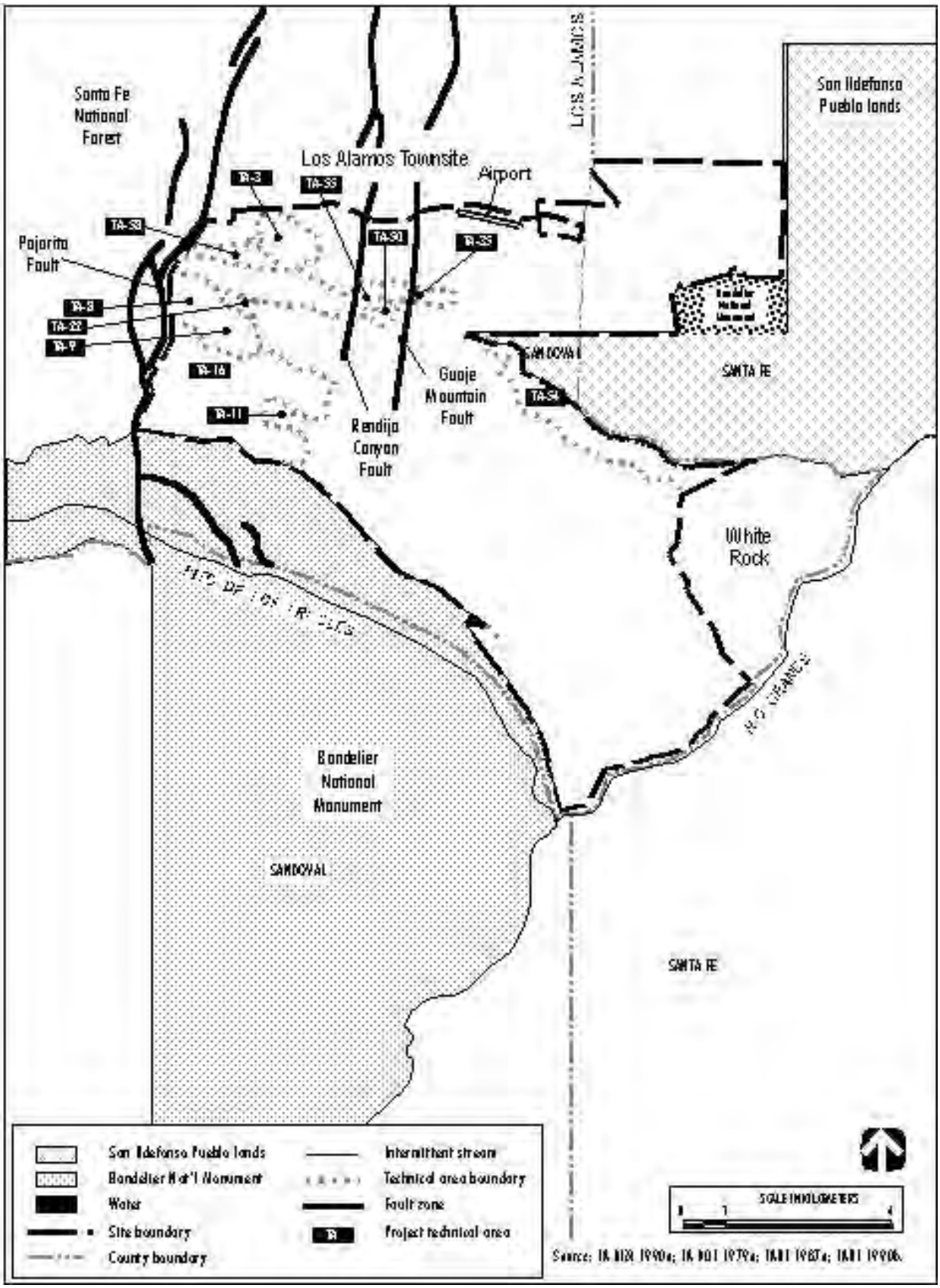


Figure 3–19 Major Fault Systems Near the Los Alamos National Laboratory Region

Table 3–27 Summary of Major Faults at Los Alamos National Laboratory

Name	*Approximate Length Mi (km)*	*Type*	*Most Recent Movement*	*Maximum Potential Earthquake* [a]
Pajarito	26 mi (42 km)	Normal, down-to-the-east [b]	Approximately 45,000 to 55,000 years ago	7
Rendija Canyon	6 mi (10 km)	Normal, down-to-the-west	8,000 to 9,000 or 23,000 years ago	6.5
Guaje Mountain	8 mi (14 km)	Normal, down-to-the-west	4,000 to 6,000 years ago	6.5

[a] Richter Magnitude

[b] The crustal block on the east side of the fault slips downward toward the east when fault movement occurs. This results in a fault plane for the Pajarito Fault, for example, which runs under Los Alamos National Laboratory toward the east. A normal west fault involves the crustal block on the west side of the fault slipping downward toward the west.

3.3.6 Ecology

- **Terrestrial Resources—** Los Alamos National Laboratory lies within the Colorado Plateau Province. Ecosystems within the laboratory site itself are diverse due to the 1,500-m (5,000-ft) elevational gradient from the Rio Grande on the southeastern boundary to the Jemez Mountains, 20 km (12.4 mi) to the west, and to the many canyons with abrupt slope changes that dissect the site. Only a small portion of the total land area at Los Alamos National Laboratory has been developed. The remaining land has been classified into six major vegetative communities. Within Los Alamos National Laboratory, the predominant community types are juniper grassland in the eastern third, pinyon-juniper in the central third, and ponderosa pine in the western third. The juniper-grassland community is found along the Rio Grande on the eastern border of the Pajarito plateau and extends upward on the south-facing sides of the canyons at 1,700 to 1,900 m (5,600 to 6,200 ft). The pinyon-juniper community, generally found in the 1,900- to 2,100-m (6,200- to 6,900-ft) elevation range, includes large portions of the mesa tops and north-facing slopes at the lower elevations. The ponderosa pine community is found in the western portion of the plateau and on mesa tops in the 2,100- to 2,300 m (6,900- to 7,500-ft) elevation range. Coniferous trees are the dominant vegetation in the Los Alamos National Laboratory environs, with pinyon pine and one-seed juniper predominant below 2,100 m (6,900 ft), and ponderosa pine and Douglas fir predominant above that elevation (DOE 1995). Almost 350 vascular plant species have been found, or are likely to be found, on Los Alamos National Laboratory (DOE 1979).

Terrestrial animal species that can be found on or near Los Alamos National Laboratory include 1 amphibian, 9 reptile, 189 bird, and 45 mammal species. Undeveloped areas within Los Alamos National Laboratory provide habitat for a diversity of terrestrial wildlife. Species lists have been compiled from observational data and published data, but the occurrence of some species has not been verified. Among vertebrates, the collared lizard, eastern fence lizard, and whiptail lizard are some of the reptiles found at Los Alamos National Laboratory. Typically, these are found at elevations between 1,910 and 2,134 m (6,265 and 7,000 ft). Bird species that nest in the area include the Mexican spotted owl, great-horned owl, and red-tailed hawk among the raptors, and Say's phoebe lesser goldfinch, and American robin among other types.

Overwintering species include the scrub jay, common raven, and house finch. Migratory birds and their nests and eggs are protected by the Migratory Bird Treaty Act. Eagles are similarly protected by the Bald Eagle Protection Act (DOE 1996a).

Some of the larger mammals at Los Alamos National Laboratory are the American black bear, coyote, and raccoon, while the smaller species include the Mexican woodrat, deer mouse, Abert's squirrel, and mountain cottontail. The most important and prevalent big game species at Los Alamos National Laboratory are mule deer and elk. Since 1980, the number of elk using Los Alamos National Laboratory lands increased significantly. Studies of elk conducted from 1991 to 1993 revealed increased use of habitats north and northeast of previously documented high-use areas. There have also been concerns about increases in motor vehicle accidents involving elk and deer in the Los Alamos National Laboratory area. Los Alamos National Laboratory lands have traditionally been a transitional area for wintering elk and mule deer. More recently, these two species have been using Los Alamos National Laboratory property on a year-round basis (DOE 1996a).

- **Wetlands—**National Wetland Inventory maps show that most Los Alamos National Laboratory wetlands occur in canyons that drain to the Rio Grande. Wetlands are found in most of the canyons on the laboratory site including Pueblo, Los Alamos, Sandia, Mortendad, Pajarito, Water, Ancho, Chaquchi, and White Rock (Rio Grande) Canyons. Wetlands have also developed in the vicinity of outfalls from Los Alamos National Laboratory facilities. Most wetlands are classified as riverine intermittent, meaning they may contain flowing water part of the year and may contain pooled water or be dry the remainder of the year. Palustrine emergent and/or scrub-shrub wetlands are also indicated in sections of Pueblo, Los Alamos, Sandia, Pajarito, and Ancho Canyons. Most of the riverine and palustrine wetlands known to exist at Los Alamos National Laboratory are designated as temporary or seasonal by the National Wetlands Inventory maps (DOE 1996a).

- **Aquatic Resources—**Aquatic habitats at Los Alamos National Laboratory are limited to the Rio Grande and several springs and intermittent streams in the canyons. Some of these habitats currently receive National Pollutant Discharge Elimination System-permitted wastewater discharges. The springs and streams at Los Alamos National Laboratory do not support fish; however, many other aquatic species thrive in these waters.

The Rio Grande is located along the southeastern property boundary and supports populations of common carp, chub, white sucker, and carpsucker. Game fish inhabiting the Rio Grande in the vicinity of Los Alamos National Laboratory include the channel catfish and brown trout.

- **Threatened and Endangered Species—Table 3-28** lists Federal- or State-listed threatened, endangered, and other special status species may be found on and in the vicinity of Los Alamos National Laboratory. Four of these species have been observed on Los Alamos National Laboratory. The Federal-listed species recorded onsite include the Mexican spotted owl, the bald eagle, which winters along the Rio Grande River, and the peregrine falcon, which historically nested onsite and occasionally still forages there. Los Alamos National Laboratory canyons provide suitable nesting, roosting, and foraging habitats for the Mexican spotted owl. No critical habitat for threatened or endangered species, as designated under the Endangered Species Act (50 CFR 17.95; 50 CFR 17.96), exists on Los Alamos National Laboratory; however, critical habitat for the Mexican spotted owl has been designated in areas bordering the northern and western boundaries of Los Alamos National Laboratory (60 FR 29914).

3.3.7 Cultural and Paleontological Resources

More than 1,300 prehistoric sites and 80 historic resources have been recorded at Los Alamos National Laboratory, and approximately 95 percent of these sites and 90 percent of the resources are considered eligible or potentially eligible for the National Register of Historic Places. Native Americans in the area include the six Tewa-speaking Pueblos of the northern Rio Grande Valley (San Ildefonso, San Juan, Santa Clara, Nambe,

Tesuque, and Pojoaque) and the Cochiti and Jemez Pueblos. None of the formations within Los Alamos National Laboratory are known to be fossiliferous. Additional information about cultural and paleontological resources at the site can be found in the *Draft Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory* (LANL 1998).

Table 3–28 Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Los Alamos National Laboratory

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Big free-tailed bat	*Nyctinomops macrotis*	C2	NL
Cave myotis	*Myotis velifer*	C2	NL
Fringed myotis	*Myotis thysanodes*	C2	NL
Goat peak pika	*Ochotona princeps nigrescens*	C2	NL
Long-eared myotis	*Myotis evotis*	C2	NL
Long-legged myotis	*Myotis volans*	C2	NL
New Mexican meadow jumping mouse	*Zapus hudsoniums luteus*	C2	T
Occult little brown bat	*Myotis lucifugus occultus*	C2	NL
Pale Townsend's big-eared bat	*Plecotus townsendii pallescens*	C2	NL
Small-footed myotis	*Myotis ciliolabrum*	C2	NL
Spotted bat	*Euderma maculatum*	C2	T
Yuma myotis	*Myotis yumanensis*	C2	NL
Birds			
Bald eagle[b, c]	*Haliaeetus leucocephalus*	T	T
Broad-billed hummingbird	*Cynanthus latirostris*	NL	T
Common black hawk	*Beuteogallus athracinus*	NL	T
Ferruginous hawk	*Buteo regalis*	C2	NL
Gray vireo	*Vireo vicinior*	NL	T
Mexican spotted owl[c]	*Strix occidentalis lucida*	T	NL
Northern goshawk[c]	*Accipiter gentilis*	C2	NL
Peregrine falcon[b, c]	*Falcon peregrinus*	E (S/A)	E
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	T
Western burrowing owls	*Athene cunicularia hypugea*	C2	NL
White-faced ibis	*Plegadis chihi*	C2	NL
Whooping crane[b]	*Grus americana*	E	E
Fish			
Flathead chub	*Platygobio gracilis*	C2	NL
Rio Grande silvery minnow	*Hybognathus amarus*	E	T
Invertebrates			
Say's pond snail	*Lymnaea caperata*	NL	E
Plants			
Checker lily	*Fritillaria atropurpurea*	NL	R
Giant helleborine orchid[c]	*Epipactis gigantea*	NL	RS
Paper-spined cactus	*Pediocactus papyracanthus*	C2	NL
Sandia alumroot	*Heuchera pulchella*	NL	RS
Santa Fe cholla	*Opuntia viridiflora*	C2	E
Wood lily	*Lilium philadelphicum var. andinum*	NL	E

[a] Status codes: C2 - Federal candidate - Category 2 (possibly appropriate for listing); E - Endangered; NL - not listed; R - State rare plant review list; RS - State rare and sensitive plant species; T - threatened; S/A - protected under the similarity of appearances provision of the *Endangered Species Act*.

[b] U.S. Fish and Wildlife Service Recovery Plan exists for this species.

[c] Species recorded on Los Alamos National Laboratory.

Source: Adapted from DOE 1996a.

3.3.8 Socioeconomics

- **Regional Economy—**Between 1980 and 1990, the civilian labor force in the regional economic area increased from 74,759 to 100,257, a 34-percent increase (annual average increase of 3.4 percent). The regional economic area encompasses seven counties around the site located in New Mexico. In 1994, unemployment in the regional economic area was 6.2 percent compared to 6.3 percent for New Mexico. The region's per capita income of $17,689 in 1993 was approximately 8.2 percent higher than New Mexico's per capita income of $16,346. The regional economic area and New Mexico have similar employment patterns. The service sector accounts for the largest share of total employment in both the region (31 percent) and in New Mexico (28 percent). Manufacturing employment accounted for 4 percent of the total regional employment but 6 percent of the total State employment (DOE 1996a).

- **Population and Housing—**Between 1980 and 1992, the population residing within the Los Alamos National Laboratory region of influence grew from 122,241 to 158,249, an increase of 29.5 percent (annual average increase of 2.5 percent). The region of influence is a three-county area (Los Alamos County, Rio Arriba County, and Santa Fe County) in which almost 90 percent of all site employees reside. Within the region of influence, however, Santa Fe County increased by 39.6 percent (annual average increase of 3.3 percent). Population growth in Los Alamos was nearly stagnant during the same period. The unincorporated communities of Los Alamos and White Rock in Los Alamos County are included in the county population and housing analysis (DOE 1996a).

The number of housing units increased from 46,006 in 1980 to 63,386 units in 1990, an increase of 37.8 percent (annual average increase of 3.8 percent). The 1990 homeowner vacancy rate in the region of influence was 2.3 percent. The rental vacancy rate for the region of influence counties was 7.7 percent. **Figure 3–20** shows the racial and ethnic composition of minorities residing within an 80-km (50-mi) radius of Los Alamos National Laboratory at the time of the 1990 census.

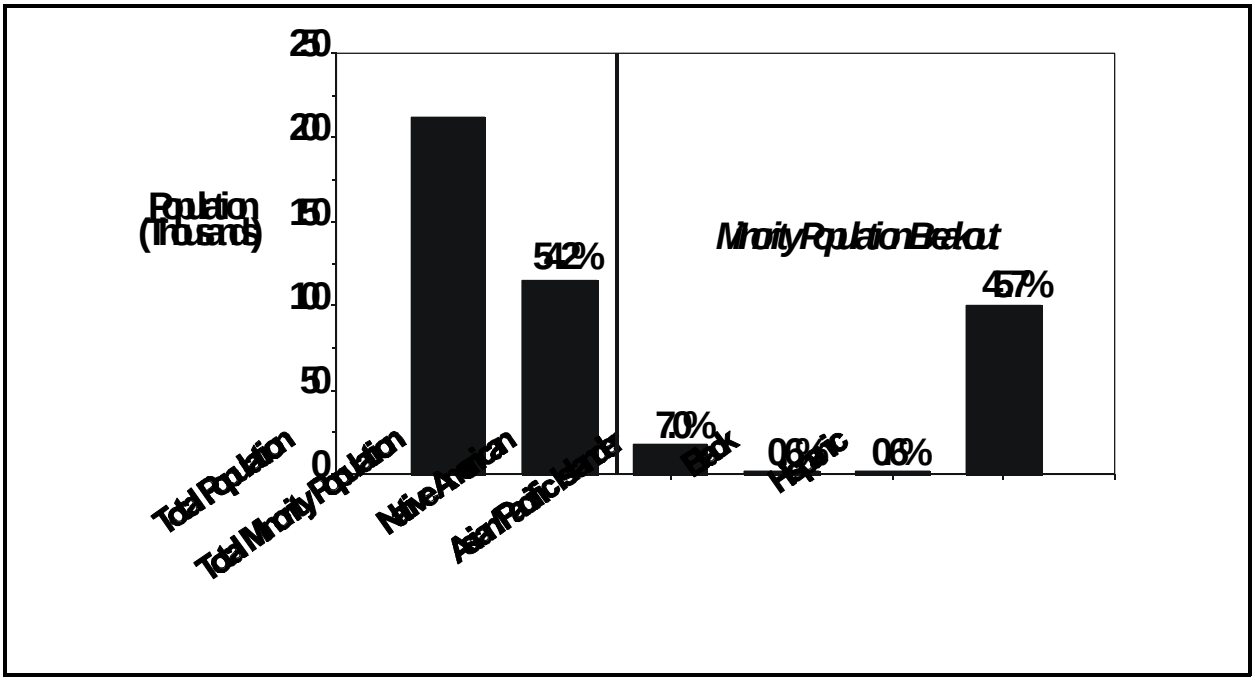


Figure 3–20 Racial and Ethnic Composition of the Minority Population Residing Within 80 km (50 mi) of the Los Alamos National Laboratory

As a percentage of the total state population, the State of New Mexico has the largest minority population among the contiguous Unites States. During the decennial census of 1990 (DOC 1992b), minorities were found to comprise nearly 50 percent of New Mexico's population. Minorities comprised approximately 54 percent of the population residing within 80 km (50 mi) of candidate facilities at Los Alamos National Laboratory. Nearly 46 percent of the total population at risk was Hispanic, while 7 percent of the total population at risk was comprised of Native Americans. Together, Hispanics and Native Americans comprised over 97 percent of the total minority population in the area potentially impacted by the proposed action and alternatives. Among the Native American pueblos in the Los Alamos-Santa Fe Area, the Pueblo of San Ildefonso, Pueblo of Santa Clara, Pueblo de Cochiti, and Pueblo of Jemez are closest in proximity to Los Alamos National Laboratory. Lands of the San Ildefonso Pueblo are adjacent to the eastern boundary of Los Alamos National Laboratory (see Figure 3–19). As illustrated in **Figure 3-21**, the minority population exceeded 48 percent of the total population (more than twice the national minority percentage in 1990) in areas throughout the potentially affected region.

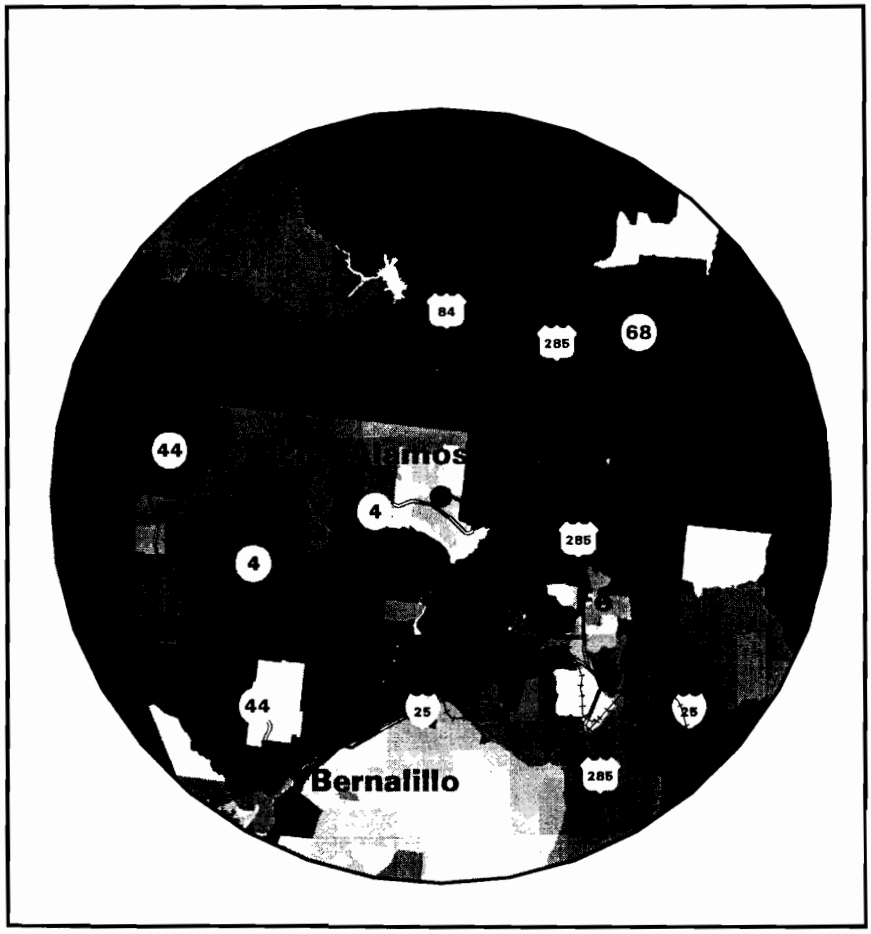
As shown in Table F-3 of Appendix F, about 15 percent of the individuals residing within the region of influence had a self-reported income less than the poverty level. As discussed in Appendix F, the poverty level is a function of family size and number of unmarried children in the family under 18 years of age. The national percentage of individuals with income less than the poverty level in 1995 is estimated by the Census Bureau to be 13.8 percent. The national percentage of individuals residing in the continental United States with income below the poverty level was 13.3 percent at the time of the 1990 census. **Figure 3–22** shows the distribution of poverty-level individuals residing within the region of influence. As shown in the figure, there are areas throughout the region of influence in which the percentage of residents with income below the poverty level was a factor of two or more larger than the national average.

3.3.9 Public and Occupational Health and Safety

- **Radiation Environment—**Major sources of background radiation exposure to individuals in the vicinity of Los Alamos National Laboratory are shown in **Table 3–29**. Annual doses to individuals from background radiation are expected to remain constant over time. Total dose to the population changes as the population size changes. Background radiation doses are unrelated to Los Alamos National Laboratory operations.

Releases of radionuclides to the environment from Los Alamos National Laboratory operations provide another source of radiation exposure to individuals in the vicinity of Los Alamos National Laboratory. The radionuclides and quantities released from Los Alamos National Laboratory operations in 1995 are listed in *Environmental Surveillance at Los Alamos During 1995* (LANL 1996). Doses to the public resulting from these releases and direct radiation are presented in **Table 3–30.** These doses fall within regulatory limits given in DOE Order 5400.5 and are small in comparison to background radiation.

Workers at Los Alamos National Laboratory receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. **Table 3–31** includes the average, maximum, and total occupational doses to Los Alamos National Laboratory workers from operations during the period of 1991 through 1995.



LEGEND

- Site
- Surface Water Shoreline
- Rail Lines
- State & US Highways
- 0 <= Pm < 12%
- 12% <= Pm < 24%
- 24% <= Pm < 48%
- Pm >= 48%

SUMMARY STATISTICS	
WITHIN 80 KM (50 MILES) RADIUS OF THE SITE	
TOTAL POPULATION	214,290
MINORITY POPULATION	116,091
PERCENTAGE	54%

0 5 10 15 20 25 30
miles

Figure 3–21 Distribution of Minority Population Residing Within 80 km (50 mi) of Los Alamos National Laboratory

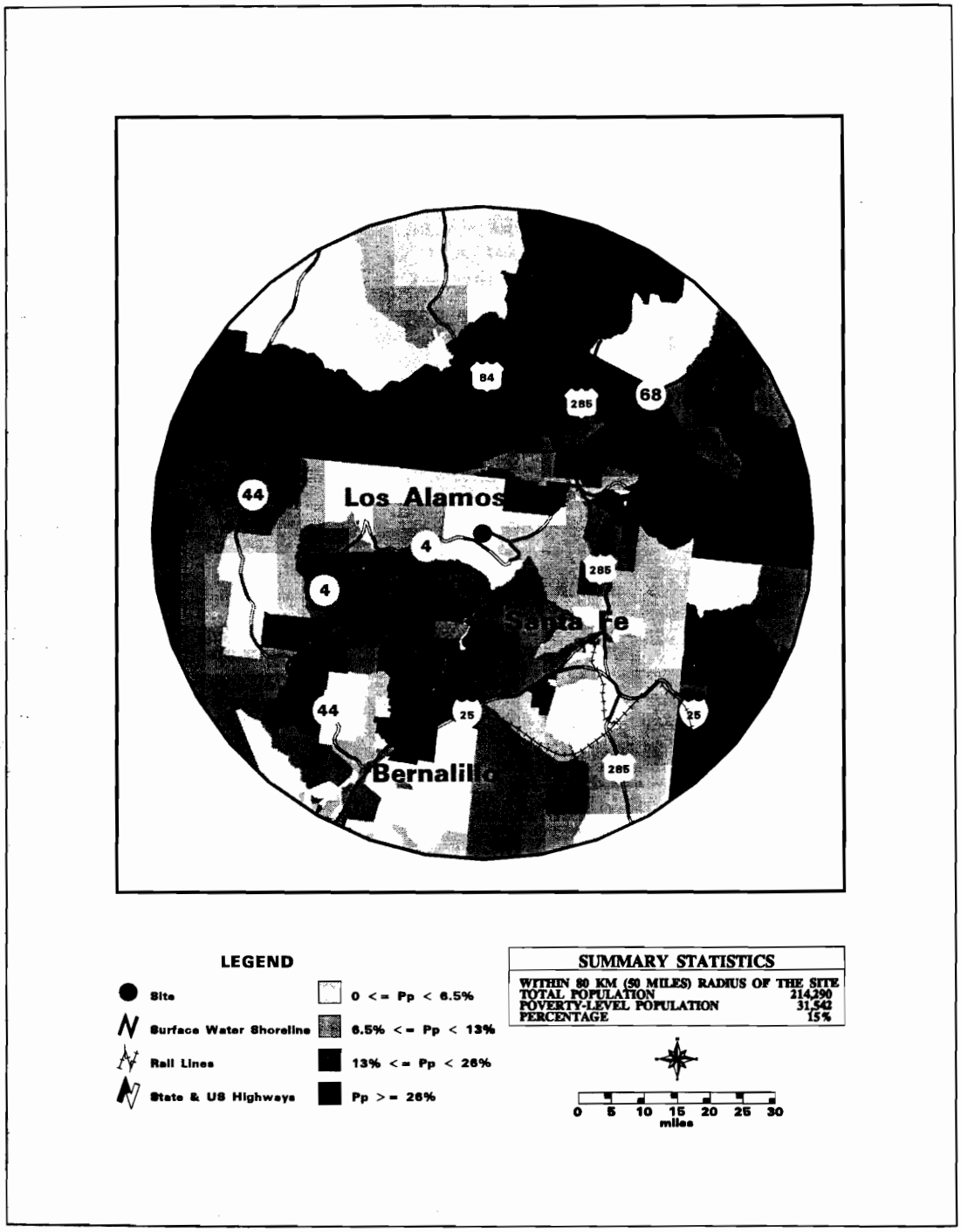


Figure 3–22 Distribution of Low-Income Population Residing Within 80 km (50 mi) of Los Alamos National Laboratory

Table 3–29 Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Los Alamos National Laboratory Operations

Source	*Committed Effective Dose Equivalent (mrem/yr)*
Natural Background Radiation[a]	
Cosmic and external terrestrial radiation	109
Internal terrestrial radiation	40
Radon in homes (inhaled)[b]	200
Other Background Radiation [a, c]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	414

[a] LANL 1996 (Chapter 3).
[b] Value for Radon is an average for the United States.
[c] NCRP 1987.

Table 3–30 Doses to the General Public from Normal Operations at Los Alamos National Laboratory, 1995 (Committed Effective Dose Equivalent)

	Atmospheric Releases		*Liquid Releases*		*Total*	
Members of the General Public	*Standard* [a]	*Actual*	*Standard* [a]	*Actual*	*Standard* [a]	*Actual*
Maximally exposed individual (mrem)	10	5.1	4	0.58	100	5.7
Population within 80 km (50 mi)[b] (person-rem)	None	3.2	None	~0[c]	None[d]	3.2
Average individual within 80 km (50 mi)[e] (mrem)	None	0.013	None	~0[c]	None	0.013

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that Order, the 10 mrem/yr limit for airborne emissions is required by the Clean Air Act. The 4 mrem/yr limit is required by the Safe Drinking Water Act, and the total dose of 100 mrem/yr is the limit from all pathways combined.
[b] In 1995, this population was approximately 241,000.
[c] Although the maximally exposed individual receives a dose, no population groups are exposed to any liquid pathways.
[d] A 100 person-rem value for the population is found in proposed 10 CFR Part 834 (58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.
[e] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.
Source: LANL 1996 (Chapter 3).

Table 3–31 Annual Doses to Onsite Workers from Normal Operations at Los Alamos National Laboratory, Period 1991–1995

	Onsite Releases and Direct Radiation	
Occupational Personnel	*Standard* [a]	*Actual* [b]
Average Worker (mrem)	None	16
Maximally exposed worker (mrem)	5,000	2,000
Total workers (person-rem)	None	165

[a] 10 CFR Part 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable. This includes maintaining doses to individual workers so far below the DOE limit of 5,000 mrem/year that no dose is expected to exceed the DOE Administrative Control Level of 2,000 mrem/year (DOE 1992a).
[b] DOE 1997c. The annual doses are averaged over the 5-year period.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in *Environmental Surveillance at Los Alamos During 1995* (LANL 1996). In addition, the concentrations of radioactivity in various environmental media (e.g., air, water, and soil) in the onsite and offsite regions are presented in the same reference.

- **Chemical Environment—**The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Section 3.3.3 on air quality and Section 3.3.4 on surface and groundwater quality.

Adverse impacts to the public are minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at Los Alamos National Laboratory via inhalation of air containing hazardous chemicals released to the atmosphere. Risks to public health from ingestion of contaminated drinking water or direct exposure are also potential concerns.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards were presented in Section 3.3.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed.

Exposure pathways to Los Alamos National Laboratory workers during normal operations may include inhaling air in the workplace atmosphere, drinking water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a numerical estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Los Alamos National Laboratory workers are also protected by adherence to Occupational Safety and Health Administration and EPA occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operation processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm.

- **Emergency Preparedness—**Each of DOE's sites have established an emergency management program that would be activated in the event of an accident. These programs have been developed and maintained to ensure adequate response for most accident conditions. Emergency management programs incorporate activities associated with emergency planning, preparedness, and response. The Los Alamos National Laboratory Emergency Preparedness Plan is designed to minimize or mitigate the impact of any emergency upon the health and safety of employees and the public.

3.3.10 Waste Management

Table 3–32 presents a summary of waste management activities at Los Alamos National Laboratory. DOE cooperates with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operation of Los Alamos National Laboratory. Several activities are now conducted to bring its current operations into full regulatory compliance. These activities are set forth in permits and negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones. These agreements have been reviewed to ensure the proposed actions are allowable under the terms of these agreements.

Los Alamos National Laboratory is not listed on the National Priorities List. As a function of obtaining a Resource Conservation and Recovery Act permit, however, the Hazardous and Solid Waste Amendments of 1984 mandate that permits include provisions for corrective actions to clean up contamination in areas designated as solid waste management units. By the end of 1995, over 60 of the approximately 2,100 potential release sites identified had been remediated, no further action was proposed for 575 sites, and 1,100 sites were slated for investigation or cleanup; for the remaining sites, action is still pending. Cleanup activities are expected to be completed by 2010 (LANL 1996).

Through its research activities, Los Alamos National Laboratory manages a small quantity of the following five broad waste categories: transuranic waste, low-level, mixed, hazardous, and nonhazardous wastes:

- **Transuranic Waste—**In 1993, Los Alamos National Laboratory generated approximately 54 m^3 (70 yd^3) of transuranic waste (LANL 1994a). The Plutonium Facility (Technical Area 55) is the principal generator of liquid transuranic waste at Los Alamos National Laboratory. Principal sources include process acidic and caustic wastewaters, evaporator distillates from the nitrate recovery area, cooling water from glove boxes, and wet vacuum seal water. Sludges that remain after treatment through filtration and residual evaporator bottoms are loaded into 208-L (55-gal) drums, solidified, and transported to Area G for storage. Liquid wastes remaining after filtration are transferred from Technical Area 55 to the Radioactive Liquid Waste Treatment Facility (Technical Area 50) by gravity drain in double-wall pipelines. After treatment at Technical Area 50 involving sedimentation, clarification, and flocculation, the residual radioactive sludge is loaded into drums, solidified, and transported to Area G for storage. Most of Los Alamos National Laboratory's transuranic waste is currently stored on four asphalt pads. Transuranic wastes are currently being stored until they can be shipped to the Waste Isolation Pilot Plant (WIPP), if that facility can demonstrate compliance with the requirements of 40 CFR Part 191 and 40 CFR Part 268, or to another transuranic waste disposal facility, should WIPP prove unsatisfactory.

  Should additional treatment be necessary for disposal at WIPP, Los Alamos National Laboratory would develop the appropriate treatment to meet WIPP waste acceptance criteria and package the wastes in accordance with DOE, Nuclear Regulatory Commission, and U.S. Department of Transportation requirements for transport to WIPP for disposal. Los Alamos National Laboratory is presently upgrading transuranic waste storage facilities to comply with Resource Conservation and Recovery Act requirements under the terms of a consent order with the State of New Mexico.

Table 3–32 Waste Management Activities at Los Alamos National Laboratory

Category	*1996 Generation (m^3)*	*Treatment Method*	*Treatment Capacity (m^3/yr)*	*Storage Method*	*Storage Capacity (m^3)*	*Disposal Method*	*Disposal Capacity (m^3)*
Transuranic Liquid	None	Pretreatment at TA-50: neutralization, clariflocculation, filtration, precipitate, cement mixing	48,800	N/A	N/A	N/A	N/A
Solid	77	Volume reduction	1,080	Storage pads at TA-54, modified LLW burial pits and shafts	24,355	None: Federal repository in the future	None
Mixed Transuranic Liquid	None	See transuranic	Included in transuranic	N/A	N/A	N/A	N/A
Solid	4	See transuranic	Included in transuranic	N/A	Included in transuranic	See transuranic	None
Low-Level Waste Liquid	11	Chemical treatment and ion-exchange, solidification; and volume reduction (vial crusher)	45 m^3/hour	Chemical and Ion-Exchange Plant at TA-50 and the Chemical Plant at TA-21	663	Treated effluent is discharged to the environment. Residual sludge is solidified and disposed of at TA-54, Area G, as solid LLW	None
Solid	521	Compaction	76	TA-54 in Area G	Variable	Currently solid LLW goes to TA-54, Area G for burial. Continued construction at Area G under evaluation in sitewide EIS	Estimated available capacity is 25,000 m^3
Mixed LLW Liquid	2	Neutralization, precipitation, oxidation, thermal treatment; solidification; volume reduction; liquid scintillation cocktail vials	Capabilities under development per site treatment plan	RCRA-permitted buildings (not built yet) and interim status container storage areas	583	N/A	None
Solid	5	None	Capabilities under development per site treatment plan	RCRA-permitted Bldgs. (not built yet) and interim status container storage areas	583	Capabilities under development as per Site Treatment Plan for Mixed Wastes	None
Hazardous Waste Liquid	None	Thermal treatment, treatment tanks, neutralization, precipitation, and evaporation	Varies depending on the waste stream	Thermal treatment TAs-14,-15,-16,-36, and -39 and storage and treatment TA-54, Area L	1,864	Offsite	N/A

Category	*1996 Generation (m^3)*	*Treatment Method*	*Treatment Capacity (m^3/yr)*	*Storage Method*	*Storage Capacity (m^3)*	*Disposal Method*	*Disposal Capacity (m^3)*
Solid	89 (tonnes)	Thermal treatment and flashpad	Varies depending on the waste stream	See above	See above	Offsite	N/A
Nonhazardous (Sanitary) Liquid	None	Filtration, settling, and stripping	1,060,063	N/A	N/A	Permitted discharge sanitary tile fields	2,271 m^3/day
Solid	2,057 (tonnes)	None	None	N/A	N/A	Offsite county landfill and onsite landfill Area J	N/A

TA = technical area N/A = not applicable LLW = low-level waste RCRA = Resource Conservation and Recovery Act
Source: Adapted from DOE 1996a, DOE 1997a, and DOE 1997c.

Los Alamos National Laboratory generates mixed transuranic wastes. Newly generated mixed transuranic wastes are identified, characterized, and stored in compliance with the Resource Conservation and Recovery Act. In 1993, Los Alamos National Laboratory generated approximately 255 m^3 (334 yd^3) of mixed transuranic wastes. The Federal Facility Compliance Act of 1992 requires DOE to provide specific information to the EPA and the State of New Mexico on Los Alamos National Laboratory's mixed transuranic waste streams, treatment facilities, and technology development activities. This waste category covers a broad range of physical matrix categories for Los Alamos National Laboratory. The Federal Facility Compliance Order for the Site Treatment Plan requires treatment of all mixed wastes not in compliance with the land disposal provisions of the Resource Conservation and Recovery Act. This compliance order is the implementation of the Federal Facility Compliance Act at Los Alamos National Laboratory. WIPP waste acceptance criteria specifies limiting parameters for waste containers, waste form, waste packaging, accompanying data, and miscellaneous packaging and Resource Conservation and Recovery Act requirements. WIPP has specific Resource Conservation and Recovery Act hazardous waste codes that it can accept without requiring the treatment of the waste forms. WIPP's waste acceptance criteria must be met prior to the shipment of mixed wastes to WIPP. Los Alamos National Laboratory has developed a WIPP transuranic waste characterization program (including hazardous waste characterization) to meet the waste acceptance criteria.

- **Low-Level Waste—**Both liquid and solid low-level waste are generated and managed by Los Alamos National Laboratory. In 1993, Los Alamos National Laboratory generated approximately 21,400 m^3 (5,653,000 gal) of liquid and 2,693 m^3 (3,523 yd^3) of solid low-level waste. Liquid low-level waste is generated from many areas throughout Los Alamos National Laboratory. There are two wastewater treatment facilities used for treatment of aqueous low-level waste, one of which utilizes ion-exchange technology. As part of a new radioactive liquid waste treatment facility project, a facility for the solidification and subsequent volume reduction of the radioactive liquid waste treatment plant sludge containing plutonium, americium, and other radionuclides is proposed but not funded at Los Alamos National Laboratory.

  Solid low-level waste is generated from many areas throughout Los Alamos National Laboratory. Solid low-level waste, such as paper, plastic, glassware, and rags, is separated into compactible and noncompactible materials by the waste generators. Compactible bales are banded, wrapped and sealed in plastic, and moved to Area G for disposal in landfill pits located at Technical Area 54 Low-level waste noncompactible items, such as large equipment and much of the decontamination and decommissioning waste, generally are not packaged but delivered to the burial site in covered or enclosed vehicles. Continued construction at Area G is dependent on decisions made in conjunction with the Los Alamos National Laboratory *Draft Site-Wide Environmental Impact Statement for Continued Operation of Los Alamost National Laboratory* (LANL 1998).

- **Mixed Low-Level Waste—**In 1993, Los Alamos National Laboratory generated approximately 45 m^3 (59 yd^3) of mixed low-level waste (LANL 1994b). Mixed low-level waste includes solvents, pyrophoric substances, spray cans, scintillation vials, uranium-contaminated lithium hydride, miscellaneous reagent chemicals, vacuum pump oil contaminated with mercury, gas cylinders, and other contaminated material. It is stored at Technical Area-54 Areas L and G. Currently, Los Alamos National Laboratory does not dispose of mixed low-level waste. In accordance with the Federal Facility Compliance Act of 1992, Los Alamos National Laboratory has developed a site treatment plan that covers management of all mixed waste at Los Alamos National Laboratory. The State of New Mexico Environment Department issued a Compliance Order in the Site Treatment Plan for Mixed Waste in October 1995. The compliance order addresses land disposal restricted mixed waste. For mixed waste with identified treatment technologies, the plan provides a schedule for submitting permit applications, entering into contracts, initiating construction,

conducting systems testing, starting operations, and processing mixed wastes. For mixed waste without an identified treatment technology, the plan includes a schedule for identifying and developing technologies, identifying the funding requirements for research and development, submitting treatability study notifications, and submitting research and development permit applications.

Mixed waste treatment skids are being designed to treat onsite hazardous and mixed waste streams that are not amenable to offsite treatment. Examples of the waste streams potentially amenable to skid treatment are reactive metals, plating wastes, acids, bases, ignitable liquids, spent solvents, and decontamination debris. Not all of the technologies to be included have been chosen. The mixed waste treatment skids would be housed in an existing Los Alamos National Laboratory structure. An environmental restoration high-energy plasma technology is being tested as a technique for total destruction of mixed low-level waste that has been treated to land disposal restrictions standards. This technique will allow Los Alamos National Laboratory to stay in compliance with the Federal Facility Compliance Act of 1992.

- **Hazardous Waste—**Los Alamos National Laboratory received a permit for treatment, storage, and disposal of hazardous waste under the Resource Conservation and Recovery Act in November 1989 and for the Hazardous and Solid Waste Amendments of 1984 provisions from the EPA on March 8, 1990. All hazardous waste treatment and storage facilities at Los Alamos National Laboratory are either fully permitted or are operating under interim status, while other waste management facilities are being developed.

  Los Alamos National Laboratory produces a wide variety of hazardous wastes. In 1993, Los Alamos National Laboratory generated approximately 84 metric tons (93 tons) of Resource Conservation and Recovery Act-regulated, 460 metric tons (507 tons) of State-regulated waste, and 124 metric tons (137 tons) of solid hazardous waste (LANL 1994b). Small volumes of almost all wastes listed under 40 CFR Part 261 are generated as a result of a wide variety of ongoing research. High explosive waste is generated during the processing and testing of various high explosive materials. All high explosive hazardous waste and potentially contaminated high explosive waste is picked up from the generating facility and treated by open detonation, open burning, or incineration at Technical Areas 14, 15, 16, 36, and 39. Ash residue is then treated and, when its hazardous characteristic can be removed and it is determined that this residue does not contain radioactive constituents, it is disposed of onsite in the landfill, Technical Area 54, Area J. The high explosive wastewater is treated by gravity settlement in a sump and discharged from outfalls permitted under the National Pollutant Discharge Elimination System. Los Alamos National Laboratory is developing a high explosive wastewater treatment facility that will collect and treat these wastewaters with stepped filtration.

  Los Alamos National Laboratory does not landfill Resource Conservation and Recovery Act hazardous waste onsite, but contracts with certified transporters to deliver hazardous waste to commercial offsite Resource Conservation and Recovery Act-permitted treatment, storage, and disposal facilities. Before waste is sent offsite, the potential treatment or disposal facility is inspected by Los Alamos National Laboratory personnel. Operating records and permits are also reviewed. Los Alamos National Laboratory has an EPA Letter of Authorization allowing disposal of solid polychlorinated biphenyl-contaminated articles at the Technical Area 54, Area G landfill. Other polychlorinated biphenyl waste and liquid polychlorinated biphenyl-contaminated articles are sent offsite to Toxic Substances Control Act-regulated disposal facilities. Asbestos mixed waste is buried at Technical Area 54, Area G. Asbestos waste is shipped offsite to an approved disposal site in accordance with Toxic Substances Control Act and National Emission Standards for Hazardous Air Pollutants regulations. Infectious wastes are managed according to State of New Mexico regulations.

- **Nonhazardous Waste—**In 1993, Los Alamos National Laboratory generated 8,180 metric tons (9,017 tons) of solid sanitary wastes. Solid sanitary wastes are generated routinely and include general facility refuse such as paper, cardboard, glass, wood, plastic, scrap, metal containers, dirt, and rubble. Solid sanitary wastes are segregated and recycled whenever possible. Trash is accumulated onsite in dumpsters, which are emptied on a regular basis by a commercial waste disposal firm and taken to the county sanitary landfill. The Los Alamos County landfill is located on property owned by DOE and is operated under a special-use permit. Approximately one-third of the solid sanitary waste disposed of at the county landfill originates from Los Alamos National Laboratory. The Area J special waste landfill, which is operated by and under the administrative control of Los Alamos National Laboratory, receives only administratively controlled solid sanitary waste. Solid sanitary waste will be managed and disposed of at the Los Alamos County Landfill until about the year 2012, when it is estimated that the existing sanitary landfill may reach the end of its useful life. At that time, either a new landfill will have to be constructed or provisions made for offsite disposal.

  Los Alamos National Laboratory generates approximately 693,000 m^3 (183,000,000 gal) of liquid sanitary waste (DOE 1993c). A new sanitary wastewater treatment plant and collection system to replace 7 existing wastewater treatment facilities and 30 existing septic tanks have been completed. The new treatment plant enables reuse of the treated wastewater for nondrinking water uses such as cooling and irrigation. The plant and collection system is designed to meet the requirements of Los Alamos National Laboratory's existing Federal Facility Compliance Agreement and is expected to meet all of Los Alamos National Laboratory's needs for the next 20 years.

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4. ENVIRONMENTAL CONSEQUENCES

4.1 OVERVIEW OF ENVIRONMENTAL IMPACTS

The impacts associated with incident-free operation and during postulated accidents are presented and discussed in this chapter. Supplemental information and supporting data are given in Appendices B through F. Many of the impacts in this chapter are different from the impacts presented in the Draft EIS. Some of the changes occurred because DOE re-evaluated many of the processing technologies. DOE also changed the frequency of severe damage due to earthquakes at Buildings 707 and 707A at Rocky Flats because structural calculations were finished after the Draft EIS was published. Furthermore, the calculations of the potential for worker health impacts due to exposure to hazardous chemicals were changed to account for more realistic assumptions.

4.1.1 Presentation of the Environmental Impacts

Nineteen categories and subcategories of plutonium residues and scrub alloy are analyzed in this Environmental Impact Statement (EIS). The material in each category can be processed with various technologies, some of which would require transporting the material from the Rocky Flats Environmental Technology Site (Rocky Flats) to another U.S. Department of Energy (DOE) site.

For each material category, the impacts associated with any given procesing technology can be compared to the impacts associated with other processing technologies for the same material category. This analytical approach allows decision makers and the public to understand the impacts of each processing technology for each material category and subcategory independently. The impacts of each processing technology for the 19 material categories and subcategories are presented and compared to each other in Sections 4.2 through 4.11.

The first processing technology listed under each material category in Sections 4.2 through 4.11 is the no action processing technology. To calculate the total impacts of processing all the plutonium residues and scrub alloy under the No Action Alternative, DOE summed the impacts that would result from the no action processing technologies for all material categories. The total environmental impacts of the No Action Alternative are presented in Section 4.20.

The Preferred Alternative is a set of specific processing technologies, one for each material category. To calculate the total impacts of processing all the plutonium residues and scrub alloy under the Preferred Alternative, DOE summed the impacts that would result from the preferred processing technologies for each material category. The total environmental impacts of the Preferred Alternative are presented in Section 4.21.

In addition to the No Action and Preferred Alternatives, DOE analyzed six other strategic management approaches. The environmental impacts of all eight strategic management approaches are compared to each other in Section 4.22.

Finally, DOE has determined the lowest and highest potential impacts associated with all materials in this EIS at each site to obtain the range of potential impacts at each site. These impacts are presented in Section 4.23. Similarly, transportation from Rocky Flats to other sites for processing would generate impacts, and the range of these impacts is presented in Section 4.24. Cumulative impacts are discussed in Section 4.25.

The primary impacts of concern are products and wastes and impacts on the public and occupational health and safety associated with the various plutonium residue and scrub alloy management activities. Additional impacts and topics covered in Chapter 4 include the following:

- Nuclear Nonproliferation
- Air Quality
- Water Quality
- Post-processing Storage
- Post-processing Transportation
- Disposal/Disposition Activities
- Environmental Justice
- Costs
- Socioeconomics
- Materials, Utilities, and Energy
- Short-term versus Long-term Resource Commitments
- Irreversible and Irretrievable Resource Commitments.

Several kinds of impacts are not discussed in Chapter 4 because they will not occur, they will be extremely small, and/or they are covered by other analyses:

- **Land—**The management of plutonium residues and scrub alloy would not require the construction of new facilities on previously undisturbed land at Rocky Flats, the Savannah River Site, or Los Alamos National Laboratory. If any additional waste storage buildings are required, they would be constructed on land which has already been used for industrial purposes. New construction, if necessary, would have no impact on undisturbed land resources. In the event of a major accident, some radioactive material could be deposited on the land downwind of the accident site. Analysis of this impact is covered in site-specific and facility-specific environmental and safety documentation.

- **Intrasite Transportation—**The incident-free impacts of intrasite transportation are limited to radiation exposure to workers loading and unloading trucks and are included in the overall worker dose values presented for each process. The accident risks are bounded by the site accident risk analysis. Strict site safety procedures and short travel distances limit the impacts to workers.

- **Noise—**Noise impacts at the processing sites should be minor and limited to noises generated during operations. If a new building is required for storage of residues at Rocky Flats, impacts from construction noise would not extend beyond the site boundaries. No offsite noise impacts are expected except for minor changes in traffic noise levels.

- **Ecological Resources—**Because no new construction in undisturbed areas would be required for DOE's management of plutonium residues and scrub alloy, there would be no clearing of native vegetation. Thus, there would be no negative impacts from construction on terrestrial or aquatic plants or animals.

  Scientific evidence indicates that chronic radiation doses below 0.1 rad per day do not harm animal or plant populations (IAEA 1992). This is equivalent to 100 mrem per day for direct radiation and greater than 100 mrem per day for ingestion of plutonium. Compliance with DOE Order 5400.5 to limit the exposure of the most exposed member of the public to 100 mrem per year (i.e., about 0.3 mrem per day) makes it highly probable that dose rates to plants and animals in the same area would be less than 0.1 rad per day.

Therefore, no radiological damage to plant and animal populations would be expected as the result of the plutonium residue and scrub alloy management activities.

Chemicals emitted to the environment during routine processing activities are presented in Appendix D, Section D.4.3. In addition, Section 4-12 contains modeled airborne concentrations for the chemicals emitted that have the potential to impact plants or animals. Most of these chemicals should not impact plants or animals because either the amounts emitted are very low or the chemicals have little potential for causing negative effects. However, at high enough concentrations the strong acids (e.g., nitric acid, hydrochloric acid), carbon tetrachloride, volatile organic compounds, and the gaseous fluorides have the potential to cause negative impacts in certain environments (e.g., water bodies).

DOE is continuing informal consultation with the U.S. Fish and Wildlife Service to comply with Section 7 of the Endangered Species Act. DOE has determined, based on analyses in this Final EIS, that the proposed action, including the preferred alternative, is not likely to adversely affect threatened or endangered species or critical habitats. DOE will forward this determination to the U.S. Fish and Wildlife Service to complete the consultation prior to issuing the Record of Decision.

For the reasons discussed above, no adverse impacts to ecological resources would be expected to occur due to DOE's management of plutonium residues and scrub alloy.

- **Cultural and Paleontological Resources**—Any new facility construction would be in previously disturbed areas, where any near-surface cultural or paleontological resources probably would have been obliterated by past construction. Any new facilities required for residues storage probably would be prefabricated buildings that could be erected with only limited excavation.

4.1.2 Products and Wastes

- **Generation**—All the processing options in this EIS would change plutonium residues or scrub alloy into other forms. Plutonium residues and scrub alloy are the inputs—products and wastes are the outputs. The products and wastes are better suited for storage, transportation, and disposal or other disposition than the existing plutonium residues and scrub alloy. The products and wastes fall into several distinct categories:

  - **Stabilized residues** would be generated under Alternatives 1 and 4. As the term is used in this EIS, stabilized residues contain plutonium concentrations in excess of the safeguards termination limits. Thus, stabilized residues would not be acceptable for disposal at the Waste Isolation Pilot Plant (WIPP) unless a variance to the safeguards termination limits is applied. DOE has approved variances for several specific stabilized residues. These stabilized residues from Alternative 4 would be acceptable for disposal in WIPP as transuranic waste.

  - **Transuranic waste** refers to processed materials that contain plutonium concentrations below the safeguards termination limits. It also refers to secondary waste, such as disposable clothing and laboratory equipment. Transuranic waste would be generated from all plutonium residues and scrub alloy under all the processing technologies. This waste could be disposed of in WIPP.

  - Materials to be managed as **high-level waste** would be generated only at the Savannah River Site. The final form would be solid glass inside stainless steel canisters. This waste would be stored at the Savannah River Site until a monitored geologic repository is ready to receive it.

- **Separated plutonium** from the residues and/or scrub alloy would be in either a metal or oxide form. The separated plutonium would be stored in secure facilities along with the plutonium already in storage until decisions can be made about its disposition. DOE would not use this plutonium for nuclear explosive purposes (DOE 1994b).

- **Low-level waste** would be generated from all plutonium residues and scrub alloy under all the processing options. This waste would be disposed of in existing facilities using routine procedures.

- **Saltstone** would be generated only at the Savannah River Site. Saltstone is a form of concrete containing low levels of radioactivity and would be disposed of onsite.

❒ **Waste Minimization—**DOE would incorporate the best available practices into all the processing technologies at all three sites in order to generate the smallest possible amounts of wastes, and to comply with DOE's waste minimization and pollution prevention goals. The preferred processing technology for a residue category may not always exhibit the lowest amount of waste among all the possible processing technologies, but waste generation impacts were an important consideration in identifying the preferred processing technologies and will be considered again by DOE in making decisions on processing technologies.

In 1996, Rocky Flats, through its commitment to waste minimization, was able to reduce waste generation by an estimated total of 980 cubic meters (34,600 cubic feet) at an estimated cost savings of $66,000. Rocky Flats reduced radioactive waste generation in 1996 by 10 percent compared to 1993 baseline levels, whereas, mixed waste generation was reduced by 90 percent and hazardous waste generation was reduced by 32 percent. Eight percent of sanitary waste was recycled in 1996, and 74 percent of the materials purchased under the affirmative procurement process were U.S. Environmental Protection Agency- (EPA-) designated recycled products (DOE 1997b).

The Savannah River Site conducted pollution prevention projects in 1996 that reduced waste generation by an estimated 8,400 cubic meters (296,600 cubic feet) at a cost savings of $17.4 million. Radioactive waste generation in 1996 was reduced by 63 percent compared to 1993 baseline levels. Hazardous waste generation was reduced by 12 percent, and sanitary waste generation was reduced by 58 percent compared to baseline levels. Thirty-one percent of sanitary waste was recycled in 1996, and 36 percent of the materials purchased under the affirmative procurement process were EPA-designated recycled products (DOE 1997b).

In 1996, the Los Alamos National Laboratory conducted pollution prevention projects that reduced radioactive waste generation by 70 percent compared to 1993 baseline levels. Mixed waste generation was reduced by 42 percent, hazardous waste generation was reduced by 71 percent, and sanitary waste was reduced by 26 percent over baseline levels (DOE 1997b).

4.1.3 General Radiological and Chemical Health Consequences

The methodologies used to evaluate potential radiological and chemical health effects are described in Appendix D. This section provides information about the development and interpretation of the health risk estimates.

❒ **Radiological—**The effect of radiation on people depends upon the kind of radiation exposure (alpha, beta, and neutron particles and gamma and x-rays) and the total amount of tissue exposed to radiation. The amount of radiant energy imparted to tissue from exposure to ionizing radiation is referred to as absorbed

dose. The sum of the absorbed dose to each tissue, when multiplied by certain quality and weighting factors that take into account radiation quality and different sensitivities of these various tissues, is referred to as effective dose equivalent.

An individual may be exposed to radiation from outside the body, or from inside the body because radioactive materials may enter the body by ingestion or inhalation. External dose is different from internal dose in that it is delivered only during the actual time of exposure. An internal dose, however, continues to be delivered as long as the radioactive source is in the body (although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time). The dose from internal exposure is calculated over 50 years following the initial exposure.

The regulatory annual radiation dose limits to the maximally exposed member of the public from total operations at a DOE site are 10 mrem from atmospheric pathways, 4 mrem from the drinking water pathway, and 100 mrem from all pathways combined (DOE Order 5400.5 and 40 Code of Federal Regulations (CFR) Part 61, Subpart H). The potential doses associated with the normal processing and storage of plutonium residues and scrub alloy are very small factions of these values, and total site doses will remain well within these DOE limits. For comparison, DOE estimates that the average individual in the United States receives a dose of approximately 350 mrem per year from all radiation sources combined, including natural and medical sources.

The maximally exposed individual worker doses listed in this chapter assume that an individual worker receives the maximum annual dose allowed under current DOE regulations and guidance, instead of being based on the total amount of residue. Maximally exposed individual worker doses will be kept below the DOE Standard of 5,000 mrem per year (10 CFR Part 835). Furthermore, as low as reasonably achievable principles will be exercised to maintain individual worker doses below the DOE Administrative Control Level of 2,000 mrem per year (DOE 1994d). Each DOE site also maintains its own Administrative Control Level; for the sake of consistency, however, DOE used the 2,000 mrem per year level throughout this EIS. Transportation workers (i.e., drivers) will be held to an annual limit of 100 mrem per year because they are not certified radiation workers. All worker doses are routinely monitored; if any individual worker's dose approaches the annual limit, he or she would be rotated into another job.

The collective or "population" dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. The total population dose received by the exposed population is measured in person-rem. For example, if 1,000 people each received a dose of 0.001 rem, the population dose would be 1.0 person-rem (1,000 persons × 0.001 rem = 1.0 person-rem). The same population dose (1.0 person-rem) would result if 500 people each received a dose of 0.002 rem, (500 persons × 0.002 rem = 1 person-rem).

Radiation can cause a variety of adverse health effects in people. A large dose of radiation can cause prompt death. At low doses of radiation, the most important adverse health effect for depicting the consequences of environmental and occupational radiation exposures (which are typically low doses) is the potential inducement of cancers that may lead to death in later years. This effect is referred to as latent cancer fatalities because the cancer may take years to develop and for death to occur.

In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation. These effects include nonfatal cancers among the exposed population and genetic effects in subsequent generations. **Table 4–1** shows the dose-to-effect factors for these potential effects as well as for latent cancer fatalities. For simplicity, this EIS presents estimated effects of radiation only in

terms of latent cancer fatalities. Nonfatal cancers and genetic effects are less probable consequences of radiation exposure.

Table 4–1 Risk of Latent Cancer Fatalities and Other Health Effects from Exposure to One Rem of Radiation [a]

Population [b]	*Latent Cancer Fatalities*	*Nonfatal Cancers*	*Genetic Effects*	*Total Detriment*
Workers	0.0004	0.00008	0.00008	0.00056
Public	0.0005	0.0001	0.00013	0.00073

[a] When applied to an individual, units are lifetime probability of latent cancer fatalities per rem of radiation dose. When applied to a population of individuals, units are excess number of cancers per person-rem of radiation dose. Genetic effects as used here apply to populations, not individuals.

[b] The difference between the worker risk and the general public risk is attributable to the fact that the general population includes more individuals in the more sensitive age group of less than 18 years of age.

Note: One rem equals 1,000 mrem.

The factors used in this EIS to relate a dose to its effect is 0.0004 latent cancer fatalities per person-rem for workers and 0.0005 latent cancer fatalities per person-rem for individuals among the general population. The latter factor is slightly higher because some individuals in the public, such as infants and children, are more sensitive to radiation than workers. These factors are based on the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991), and are consistent with those used by the U.S. Nuclear Regulatory Commission in its rulemaking *Standards for Protection Against Radiation* (NRC 1991). The factors apply where the dose to an individual is less than 20 rem and the dose rate is less than 10 rem per hour. At higher doses and dose rates, the factors used to relate radiation doses to latent cancer fatalities are doubled. At much higher doses, prompt effects, rather than latent cancer fatalities, may be the primary concern.

These concepts may be applied to estimate the effects of exposing a population to radiation. For example, if 100,000 people were each exposed only to natural background radiation (0.3 rem per year), 15 latent cancer fatalities per year would be expected (100,000 persons × 0.3 rem per year × 0.0005 latent cancer fatalities per person-rem = 15 latent cancer fatalities per year).

Sometimes, calculations of the number of latent cancer fatalities associated with radiation exposure do not yield whole numbers and, especially in environmental applications, may yield numbers less than 1.0. For example, if 100,000 people were each exposed to a total dose of only 1 mrem (0.001 rem), the population dose would be 100 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.05 (100,000 persons × 0.001 rem × 0.0005 latent cancer fatalities per person-rem = 0.05 latent cancer fatalities).

The *average* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people is 0.05. In most groups, nobody (zero people) would incur a latent fatal cancer from the one mrem dose each member would have received. In a small fraction of the groups, one latent fatal cancer would result; in exceptionally few groups, two or more latent fatal cancers would occur. The average number of deaths over all the groups would be 0.05 latent fatal cancers (just as the average of 0,0,0, and 1 is 1/4, or 0.25). The most likely outcome is zero latent cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to natural background radiation over a lifetime. The "number of latent cancer fatalities" corresponding to a single individual's exposure to 0.3 rem per year over a (presumed) 72-year lifetime is:

1 person × 0.3 rem per year × 72 years × 0.0005 latent cancer fatalities per person-rem = 0.011 latent cancer fatalities or slightly more than one chance in 100 of a latent cancer fatality.

Again, this should be interpreted in a statistical sense; that is, the estimated effect of natural background radiation exposure on the exposed individual would produce a 1.1 percent chance that the individual would incur a latent fatal cancer. Alternatively, this method estimates that about 1 person in 91 would die of cancers induced by natural background radiation.

The estimates of health effects from radiation doses used in this EIS are based on the linear no-threshold theory of radiation carcinogenesis, which postulates that all radiation doses, even those close to zero, are harmful. A recent examination of low radiation studies has reported that no statistically significant low-dose radiation study was found to support the linear no-threshold theory (Polycove 1997). This finding is supported by the National Council of Radiation Protection and Measurements in a report on collective dose that states ". . . essentially no human data can be said to prove or even to provide direct support for the concept of collective dose with its implicit uncertainties of nonthreshold, linearity and dose-rate independence with respect to risk" (NCRP 1995). Accordingly, calculations of health impacts based on the linear no-threshold theory may overstate the actual impacts of low radiation doses and should be viewed as an upper bound on the potential health effects.

- **Chemical**—The potential impacts of exposure to hazardous chemicals released to the atmosphere as a result of the processing of plutonium residues and scrub alloy were evaluated for the incident-free operation of processing facilities at Rocky Flats and at the Savannah River Site. No hazardous chemicals are expected to be released from the proposed processing at Los Alamos National Laboratory. The receptors considered in these evaluations include the offsite population in the vicinity of the sites and noninvolved workers located onsite at Rocky Flats and the Savannah River Site. Impacts were also evaluated for the maximally exposed individual member of the offsite and worker populations. The health effect endpoints evaluated in this analysis include excess incidences of latent cancers and chemical-specific noncancer health effects. The maximally exposed individual is located in the region with the highest estimated concentration. The Hazard Index results for the maximally exposed individual member of the public and the maximally exposed individual worker are different from those presented in the Draft EIS because the earlier calculations were more conservative than necessary and process source terms have been revised. In addition, the Final EIS considers only those chemicals which are toxic by the inhalation route of exposure. The cancer incidence probability estimates have also been revised in the Final EIS based on the revised process source terms. At Rocky Flats, the maximum concentration for the noninvolved worker is estimated to occur at a distance of 170 meters (m) (560 feet [ft]) south-southeast of Building 371. The maximum modeled offsite concentration occurred on the facility boundary 1.6 kilometers (km) (1.0 mile [mi]) northwest of the stack location. At the Savannah River Site, the maximum modeled onsite concentration occurred at a distance of 370 m (1,230 ft) west-southwest of the stack location. The maximum modeled offsite concentration occurred just outside the site boundary, at a distance of approximately 10 km (6.1 mi) northwest of the stack location (SAIC 1998).

  Appendix D, Section D.4 describes the methods, assumptions, and source terms used in evaluating the health impacts of exposures to hazardous chemicals. Not all of the chemicals potentially released from the proposed action processing at Rocky Flats and the Savannah River Site that are listed in Appendix D were used to estimate health risks. Some of the chemicals are inert (e.g., argon), some are innocuous in ambient air (e.g., calcium, calcium oxide, water vapor, and carbon dioxide) and some (e.g., fluorides) are not toxic by inhalation exposure. The toxicity of some of the chemicals is not well characterized (e.g., tributyl phosphate and n-dodecane), and some are addressed as air pollutants in Section 4.12 (e.g., volatile organic compounds, NO_x). Of the chemicals potentially released in the processing of plutonium residues and scrub

alloy, only the following hazardous chemicals have Reference Concentration (RfC) values or cancer inhalation unit risk factors available in EPA's Integrated Risk Information System (EPA 1991a, 1991b, 1995a, 1995b):

Chemical	*Cancer Inhalation Unit Risk Factor*	*Reference Concentration*
Carbon tetrachloride	0.000015 per $\mu g/m^3$	Not available
Hydrochloric acid	Not available	0.02 mg/m^3
Phosphoric acid	Not available	0.01 mg/m^3
Ammonium nitrate (as ammonia)	Not available	0.1 mg/m^3

The potential health risks resulting from exposure to hazardous chemicals released as a result of accidents at processing facilities were not quantitatively evaluated for any of the processing options considered in this EIS. The impacts of chemical exposures from relevant facility accidents at Building 371 at Rocky Flats and at the F- and H-Area separation facilities of the Savannah River Site have been evaluated in other investigations, such as the *Rocky Flats Cumulative Impacts Document* (DOE 1997), *the Rocky Flats Environmental Technology Site, Basis for Interim Operation, Building 371/374 Complex* (KHC 1997) and the Savannah River Site *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995b). The results of these analyses are summarized in Appendix D, Section D.4.5, and are incorporated in this EIS by reference. The results indicate that the consequences for the most exposed member of the offsite population and onsite noninvolved workers would be low and could be mitigated by emergency response actions. Workers involved in the facility processes may experience serious injury or fatalities as a result of their proximity to the release sources. The impacts of chemical releases as a result of accidents at the proposed plutonium residue and scrub alloy processing facilities at Building 371 at Rocky Flats and the F-Area at Savannah River Site are addressed and estimated in these other investigations. These analyses are representative of potential chemical accident risks for the proposed actions because they address the same or similar facilities using similar chemicals in relevant scenarios. Because chemical inventories for the H-Area separation facilities of the Savannah River Site are similar to those estimated for the F-Area, potential impacts also are expected to be similar.

At the Los Alamos National Laboratory, no hazardous chemicals would be used in the distillation of pyrochemical salts, and only relatively small amounts of hydrochloric acid would be used in the water leach and the acid dissolution processing of direct oxide reduction pyrochemical salts. Therefore, the potential impacts of hazardous chemical exposures from facility accidents at this site were not quantitatively evaluated in this EIS. Additional information on chemical accident risks at Los Alamos, which is incorporated by reference, is presented in the Draft Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (DOE 1998c).

4.1.4 Risks

Another concept important to the presentation of results in this EIS is the concept of risk. Risks are most important when presenting accident analysis results. The chance that an accident might occur during the conduct of an operation is called the probability of occurrence. An event that is certain to occur has a probability of 1.0 (as in a 100 percent certainty). If an accident is expected to happen once every 50 years, the frequency of occurrence is 0.02 per year (1 occurrence every 50 years = 0.02 occurrences per year). A frequency estimate can be converted to a probability statement. If the frequency of an accident is 0.02 per year, the probability of the accident occurring in a 10-year program is 0.2 (10 years × 0.02 occurrences per year).

Once the frequency (occurrences per year) and the consequences (for radiation effects, measured in terms of the number of latent cancer fatalities caused by the radiation exposure) of an accident are known, the risk can be determined. The risk per year is the product of the annual frequency of occurrence times the number of latent cancer fatalities. This annual risk expresses the expected number of latent cancer fatalities per year, taking account of both the annual chance that an accident might occur and the estimated consequence if it does occur.

For example, if the frequency of an accident were 0.2 occurrences per year and the number of latent cancer fatalities resulting from the accident were 0.05, the risk would be 0.01 latent cancer fatalities per year (0.2 occurrences per year × 0.05 latent cancer fatalities per occurrence = 0.01 latent cancer fatalities per year). Another way to express this risk (0.01 latent cancer fatalities per year) is to note that if the operation subject to the accident continued for 100 years, one latent cancer fatality would be likely to occur because of accidents during that period. This is equivalent to 1 chance in 100 that a single latent cancer fatality would be caused by the accident source for each year of operation. This risk can be related to the risk of death from other accidental causes for comparison. As an example, the risk of dying from a motor vehicle accident is about 1 chance in 80. Similarly, the risk of death for the average American from fire is approximately 1 chance in 500, and from death from accidental poisoning, the risk is about 1 chance in 1,000 (NNPP 1993).

The accident risks presented in this EIS do not always agree with the accident risks presented in site-specific safety documentation (e.g., Los Alamos National Laboratory Safety Analysis Reports, Rocky Flats Cumulative Impacts Document, etc.). The differences in the results may be attributed to differences in one or more of the following:

- Computer codes used for analysis
- Analysis data bases (e.g., population, weather, agriculture, etc.)
- Accident scenarios
- Analysis ground rules and assumptions
- Materials at risk
- Source terms released to the environment
- Source term isotopic breakdowns
- Accident frequencies
- Process durations.

4.1.5 Comparison of Health and Safety Risks with Common Risks to the Public

This section compares the increased risks to the public associated with the management of plutonium residues and scrub alloy to those of common activities, such as smoking, flying, receiving a medical x-ray, and so forth.

❒ **Risks in this EIS—**Succeeding sections in Chapter 4 evaluate the risks from radiological and nonradiological incident-free operations and accidents for all materials and processing options.

The highest increase in the incident-free population risk to the general public living near any of the DOE management sites involved in these alternatives would be 0.00019 latent cancer fatalities, as shown in Table 4–85 in Section 4.23. This risk would occur at the Savannah River Site.

The highest increase in the accident population risk to the general public living near any of the DOE management sites would be 0.66 latent cancer fatalities, as shown in Table 4–83 in Section 4.23. This risk would occur at the Rocky Flats Site.

The highest increase in the population risk to the general public along the transportation routes due to radiation exposure during ground transport would be 0.010 latent cancer fatalities (Table 4–91 in Section 4.24), if the maximum number of shipments is assumed (208 from Rocky Flats to the Savannah River Site).

Nonradiological fatalities are also unlikely. The highest increases in the risk of nonradiological fatalities to the public is through a traffic accident involving a truck transporting plutonium residues or scrub alloy. Assuming the same number of shipments (208 to the Savannah River Site), the increase in the population risk to the general public along the transportation routes would be 0.021 fatalities (Table 4–92 in Section 4.24).

- **Common Radiological Risks—Table 4–2** presents several typical sources of exposure to radiation from everyday life (DOE 1993b). The average person in the United States receives about 300 mrem each year from natural sources of radiation and about another 50 mrem from manmade sources of radiation. The largest dose listed in Table 4–2 is the 200 mrem per year from exposure to naturally-occurring radon gas. This is much higher than the dose any member of the general public would receive as the result of activities associated with the management of plutonium residues and scrub alloy.

Table 4–2 Typical Sources of Radiation, Average Individual Exposures, and Average Individual Risks

Source	*Dose Rate (mrem/yr)*	*Risk (Probability of a Latent Cancer Fatality/yr)*
Radon	200	0.0001
Internal	39	0.000020
Diagnostic x-rays	39	0.000020
Soil, rocks	28	0.000014
Cosmic rays	27	0.000014
Nuclear medicine	14	0.000007
Nuclear fuel cycle	less than 1	less than 5×10^{-7}
Fallout	less than 0.01	less than 5×10^{-9}

There are also large variations in radiation dose to which people are routinely exposed. For example, people who live at high altitudes receive more radiation dose than people who live at sea level. People who live or work in brick, granite, or marble buildings receive more radiation dose than people who live or work in wooden structures. People who live in well-insulated houses receive more radiation dose from trapped radon gas than people who live in well-ventilated houses. Taking all the various factors into account, the annual U.S. dose from background radiation can easily range from 100 mrem for people who live in well-ventilated wooden houses on sandy soil at sea level to about 1,000 mrem for people who live in well-insulated houses in the Denver area (de Planque 1994). Thus, in addition to the average annual radiation dose, routine variations in annual radiation dose are also much larger than the dose any member of the general public would be likely to receive under any of the alternatives.

- **Risks from Common Activities—**Every activity carries some risk. **Table 4–3** shows activities estimated to increase an individual's chance of death in any year by one in one million (Slovic 1986). Most of these activities would not be considered unusually risky actions, and they can be compared to the risks presented in this chapter for perspective only.

Table 4–3 Risks Estimated To Increase Chance of Death in any Year by One Chance in a Million

Activity	*Cause of Death*
Smoking 1.4 cigarettes	Cancer; heart disease
Living 2 days in New York or Boston	Air pollution
Traveling 16 km (10 mi) by bicycle	Accident
Flying 1,600 km (1,000 mi) by jet	Accident
Living 2 months in Denver on vacation from New York	Cancer caused by cosmic radiation
One chest x-ray	Cancer caused by radiation

4.1.6 Estimated Radiation Dose Rate Near the Plutonium Transportation Containers

The regulatory external radiation dose limit for ground transport is 10 mrem per hour at 2 m (6.6 ft) from the vehicle (49 CFR 173.441). Historical data from actual plutonium residue and scrub alloy handling experience during transportation have shown dose rates below this regulatory limit. Dose rates at 2 m (6.6 ft) from the Type 9975 and Type 6M containers have typically been between 0.15 and 0.6 mrem per hour, depending on the age and type of residue. Although Safe Secure Trailers carry up to 30 Type 9975 or 38 Type 6M containers, dose rates around the vehicle must be kept lower than the regulatory limit. If DOE makes any shipments in commercial vehicles, the same regulatory limit would also apply.

To be conservative, the analyses in this chapter use the regulatory limit of 10 mrem per hour at 2 m (6.6 ft) from the side of the transport vehicle. This conservative value was used in the calculations of incident-free doses to members of the public traveling along the highway and to ground transport workers. For radiation workers handling containers at the DOE sites, the dose rate close to the shipping containers was estimated by the conservative methodology presented in Appendix D.

4.1.7 Plutonium and Americium Toxicity

The adverse health effects experienced following exposure to plutonium result predominantly from its radiological toxicity rather than its chemical toxicity. Plutonium is not readily absorbed from the gastrointestinal tract following ingestion or through the intact skin following dermal exposure; inhalation is the most common route of human exposure. Once inhaled, the rate of clearance from the lungs is influenced by particle size, specific isotope, and chemical form. Following inhalation exposure, plutonium partitions to the lungs, liver, and bone. The radiotoxicity of plutonium results from its emission of ionizing radiation, primarily in the form of alpha particles, although low-energy gamma radiation and low-energy neutrons are also released. In studies with laboratory animals, exposure to high radiation doses of plutonium isotopes has resulted in decreases in lifespans, diseases of the respiratory tract, and cancer (ATSDR 1990, DOE 1997d). Plutonium residues and scrub alloy contain a number of different isotopes of plutonium.

In addition to plutonium isotopes, scrub alloy and some plutonium residues contain substantial amounts of americium-241, which is formed by the decay of plutonium-241. Americium-241 is radiotoxic because it produces high gamma radiation doses and also emits alpha particles and neutrons. Like plutonium, the radiotoxicity of americium is of much greater concern than its chemical toxicity (DOE 1997d).

4.1.8 WIPP Waste Acceptance Criteria

As noted in Section 4.1.2, processing the plutonium residues would produce transuranic wastes which would require disposal at WIPP. Analysis in the EIS assumes that the transuranic wastes would be transported in

the safest, cost-effective manner, which would be TRUPACT II shipping containers. Each TRUPACT II is assumed to contain approximately 2,800 fissile gram equivalents of radioactive material (primarily plutonium and americium). The Nuclear Regulatory Commission (NRC 1997) certified the 2,800 fissile gram equivalents load for the TRUPACT II in February 1997. The WIPP Supplemental EIS (DOE 1997e) analyzed the impacts of transporting the Rocky Flats wastes utilizing the 2,800-fissile-gram-equivalent TRUPACT II loading. The WIPP planning basis waste acceptance criteria has recently been revised to allow this loading.

4.1.9 Nuclear Nonproliferation Considerations

For over 40 years, the United States has supported international efforts to prevent the spread of nuclear weapons to states that do not already have them. Although the cold war has ended, national support for the nonproliferation of nuclear weapons remains undiminished. As one of its fundamental nonproliferation strategies, the United States seeks to prevent the unauthorized acquisition of materials, such as plutonium, that could be used to manufacture nuclear weapons. United States efforts to prevent unauthorized access to plutonium are based on longstanding national policies, as well as on our obligations under the Nuclear Nonproliferation Treaty and the Treaty on the Physical Protection of Nuclear Material.

The current framework for U.S. nonproliferation policy was issued by the President on September 27, 1993. Several key elements of this framework dealt with plutonium policy. The policies most directly pertinent to this EIS stated that the United States would:

- Seek to eliminate where possible the accumulation of stockpiles of highly enriched uranium or plutonium, and to ensure that where these materials already exist they are subject to the highest standards of safety, security, and international accountability;

- Submit U.S. fissile material no longer needed for our deterrent to inspection by the International Atomic Energy Agency; and

- Initiate a comprehensive review of long-term options for plutonium disposition, taking into account technical, nonproliferation, environmental, budgetary and other economic considerations.

The framework document also stated that the "United States does not encourage the civil use of plutonium and, accordingly, does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purposes."

The materials covered by this EIS (approximately 40 percent of the plutonium residues and all of the scrub alloy stored at Rocky Flats) contain nearly 2,800 kg (6,200 lb) of plutonium that could be used in nuclear weapons, if diverted. The proliferation consequences of each alternative must be considered in conjunction with considerations of the health and safety benefits (both near-term and long-term) that would be associated with implementation of the proposed action. The nonproliferation consequences of each alternative for management of these materials are discussed below.

- **Alternative 1 (No Action: Stabilize and Store)—**Under the No Action Alternative, the entire Rocky Flats inventory of plutonium residues and scrub alloy would be stabilized and stored there pending disposition. Materials containing nearly 2,800 kg (6,200 lb) of plutonium would remain an attractive target for theft by those interested in the manufacture of nuclear weapons. Theft would be prevented by continued operation of the physical security system at Rocky Flats. From the viewpoint of nuclear weapons nonproliferation, the No Action Alternative has no clearly defined endpoint. The stabilization efforts under the No Action Alternative would result in a very small reduction in proliferation risk.

- **Alternative 2 (Process without Plutonium Separation)—**Implementation of Alternative 2 would render the Rocky Flats plutonium residues and scrub alloy unattractive as source of plutonium for the manufacture of nuclear weapons. From the viewpoint of nuclear weapons nonproliferation, the endpoint is clearly defined as completion of processing for the entire inventory, at which time the resulting materials would pose a greatly reduced proliferation risk. Under this alternative, the high level of physical security required under Alternatives 1 and 3 would no longer be required for the processed plutonium residues and scrub alloy. This alternative would cause the largest reduction in the risk of proliferation and this risk reduction would occur in the near term.

- **Alternative 3 (Process with Plutonium Separation)—**Under this alternative, the chemical separation of the plutonium from the residues and scrub alloy would be conducted in the process of accomplishing the health and safety related stabilization required to comply with Defense Nuclear Facilities Safety Board Recommendation 94-1. The separated plutonium would be converted into a form that would be more attractive as a potential target for theft or diversion until its disposition if it were left unprotected. However, in the interim, prior to its disposition, this plutonium would be stored at the separation site(s) under the protection of the safeguards and security systems already in operation at those sites to provide protection for the plutonium already in storage at those sites. The separated plutonium would be disposed of in accordance with decisions to be made under the *Surplus Plutonium Disposition Draft Environmental Impact Statement.* The ultimate disposition of this plutonium would be in a monitored geologic repository as a ceramic waste form embedded in canisters of vitrified high-level radioactive waste. As a result, while there would be a slight and manageable increase in proliferation concerns in the near-term until the plutonium is dispositioned, implementation of this alternative would ultimately result in a reduction in the risk of proliferation. The waste resulting from the separation processes would not pose a proliferation risk because only minute quantities of plutonium would be present in this waste.

- **Alternative 4 (Combination of Processing Technologies)—**This alternative is a combination alternative comprised of elements of the technologies analyzed under Alternatives 1 and 2. Materials subject to processes under Alternative 4 have been granted a variance to safeguards termination limits subject to their plutonium concentration levels being below 10 percent. The variance was approved by the DOE Office of Safeguards and Security for many of the residues only after it was determined that these residues would not be in a form that is attractive for theft as a source of plutonium for use in nuclear weapons or terrorist activities. The proliferation risk is therefore very low under this alternative.

Safeguards Termination Limits

"Safeguards" are part of the process of ensuring that unauthorized persons or organizations do not obtain materials (e.g., uranium or, for this EIS, plutonium) that could be used to manufacture nuclear weapons. Safeguards termination limits are limits on the maximum concentration of plutonium that may exist in a material without causing the material to be subject to the strict material control and accountability requirements applied under "safeguards" requirements. These concentration limits are established based on a determination of how low the plutonium concentration must be for any given material form to make the material unattractive as a source of plutonium. DOE granted a variance to the safeguards termination limits for certain residues when evaluations demonstrated that the proposed processing method for the material, the controls in place for normal handling of transuranic waste, and the limited quantity of plutonium present in any particular place and time preclude the need to take additional measures to address threats of diversion and theft. When safeguards termination limit variances are applied, the residue material is no longer subject to strict material control and accountability as special nuclear material. The materials, however, are still controlled and guarded based on DOE's management practices and physical security procedures.

4.2 IMPACTS OF MANAGING ASH RESIDUES

The inventory of ash residues assessed in this EIS weighs 20,060 kg (44,224 lb) including 1,164 kg (2,566 lb) of plutonium. This inventory is stored in 1,281 drums (with approximately 6,400 internal metal containers) and 531 other small individual containers. As discussed in Chapter 2, the ash residues are divided into four subcategories. The subcategories of ash residues are listed in **Table 4–4**, along with the inventory data for each one.

Table 4–4 Ash Residues

Ash Subcategories	*Residue Mass (kg)* [a]	*Plutonium Mass (kg)* [a]	*Number of Drums*	*Number of Other Individual Containers*
Incinerator Ash (including firebrick fines)	14,056	909.8	1,016	54
Sand, Slag, and Crucible	3,062	128.9	138	214
Graphite Fines	899	74.0	81	26
Inorganic Ash	2,043	50.9	46	237
Totals	20,060	1,164	1,281	531

[a] To convert to pounds, multiply by 2.2.

Each subcategory has the same basic processing technology under the No Action Alternative: to cement and store the residue at Rocky Flats. Each subcategory has the same two or three processing technologies under the Process without Plutonium Separation Alternative. The technologies within the Process with Plutonium Separation Alternative are more complicated: the incinerator ash subcategory has two technologies, the sand, slag, and crucible subcategory has one technology, the graphite fines subcategory has one technology, and there are no technologies for the inorganic ash subcategory. Each subcategory has the same two processing technologies under Alternative 4. The preferred processing technology for all ash residues except sand, slag, and crucible residues is repackaging at Rocky Flats. The preferred processing technology for sand, slag, and crucible residues is preprocessing at Rocky Flats and Purex at the Savannah River Site.

One of the residues in the incinerator ash subcategory is not included in one of the incinerator ash processing technologies. The firebrick fines residue (Item Description Code [IDC] 378) is not included in the Purex process technology because this processing may not be feasible for this residue. This residue has a mass of 26 kg (57 lb), including 10.8 kg (23 lb) of plutonium. If DOE decides to implement this processing technology for the incinerator ash residues, then the firebrick fines residue would have to be managed under one of the other seven processing technologies. The residue mass of 26 kg (57 lb) represents less than 0.2 percent of the total residue mass in this subcategory, so DOE performed the impact calculations as if the firebrick fines were included along with the rest of the incinerator ash residues in this technology. This assumption is reasonable because the inventory of firebrick fines is very small compared to the total amount of residue in this subcategory.

This section presents the environmental impacts of managing the entire inventory of ash residues under each of the processing technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.2.1 Products and Wastes

Under every processing technology for ash residues, DOE would generate transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also result in low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would result in stabilized residues that would have to remain in storage indefinitely. In the processing technologies under the Process without Plutonium Separation Alternative, DOE would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gallon [gal]) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

Material to be managed as high-level waste (hereafter in this chapter called high-level waste) and saltstone would be generated only at the Savannah River Site if the residues were shipped to that site for plutonium separation. The final form of the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a byproduct of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults. If plutonium is separated at the Savannah River Site, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. The americium from residues sent to the Savannah River Site would go into the high-level waste.

The solid plutonium-bearing products and wastes that would be generated from ash residues under each of the technologies are presented in **Table 4–5**. The shaded areas of Table 4–5 indicate types of solid products and wastes that would not be generated under the various processing technologies. The products and wastes from the preferred processing technologies are presented in bold type.

- **Incinerator Ash and Firebrick Fines—**The largest amount of transuranic waste (6,430 drums) would be generated in the calcine and blend down technology, but the vitrify and cold ceramify technologies would generate almost as much (over 5,000 drums). These three technologies would generate much more transuranic waste than the other technologies, which would generate no more than 1,310 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste.

Thus, the two technologies under Alternative 4 would each generate over 5,500 drums (transuranic waste plus stabilized residues) to be sent to WIPP. The quantities of high-level waste, low-level waste, and saltstone are low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated from incinerator ash residues is 901 kg (1,986 lb).

- **Sand, Slag, and Crucible Residues—**The largest amount of transuranic waste (almost 1,400 drums) would be generated in the calcine and blend down technology, but the vitrify technology would generate almost as much (almost 1,200 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate fewer than 300 drums. The stabilized residues in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the two technologies under Alternative 4 would each generate over 1,000 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of high-level waste, low-level waste, and saltstone are low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated from sand, slag, and crucible residues is 128 kg (282 lb).

Table 4–5 Products and Wastes from Ash Residues

	Stabilized Residues (Drums[a])	*Transuranic Waste (Drums[a])*	*High-Level Waste (Canisters of Glass[b])*	*Separated Plutonium (kg[c])*	*Low-Level Waste (Drums[a])*	*Saltstone (cubic meters)*
Incinerator Ash and Firebrick Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	4,379	1,310			2,860	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		5,428			1,187	
Cold Ceramify at Rocky Flats		5,379			1,187	
Calcine and Blend Down at Rocky Flats		6,430			1,187	
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats		593	–	–	1,187	–
Purex at Savannah River Site		150	4	890	394	1,351
Preprocess at Rocky Flats		593	–	–	1,187	–
Mediated Electrochemical Oxidation/Purex at Savannah River Site		253	26	901	373	670
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	4,379[d]	1,310			2,860	
Repackage at Rocky Flats	**4,987[d]**	**593**			**1,187**	
Sand, Slag, and Crucible Residues						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	954	278			607	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		1,175			242	
Calcine and Blend Down at Rocky Flats		1,394			242	
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats		**122**	**–**	**–**	**242**	**–**
Purex at Savannah River Site		**12**	**4**	**128**	**58**	**357**
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	954[d]	278			607	
Repackage at Rocky Flats	773[d]	278			607	
Graphite Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	280	87			186	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		350			79	
Calcine and Blend Down at Rocky Flats		414			79	
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats		41	–	–	79	–
Mediated Electrochemical Oxidation/Purex at Savannah River Site		16	2	73	24	43
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	280[d]	87			186	
Repackage at Rocky Flats	**319[d]**	**41**			**79**	

	Stabilized Residues (Drums[a])	*Transuranic Waste (Drums[a])*	*High-Level Waste (Canisters of Glass[b])*	*Separated Plutonium (kg[c])*	*Low-Level Waste (Drums[a])*	*Saltstone (cubic meters)*
Inorganic Ash						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	637	181			395	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		779			152	
Calcine and Blend Down at Rocky Flats		924			152	
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	637[d]	181			395	
Repackage at Rocky Flats	**725**[d]	**77**			**152**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. Products and wastes from the preferred processing technologies are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

- **Graphite Fines—**The largest amount of transuranic waste (414 drums) would be generated in the calcine and blend down technology, but the vitrify technology would generate almost as much (350 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than 87 drums. The stabilized residues in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the two technologies under Alternative 4 would each generate over 350 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of high-level waste, low-level waste, and saltstone are low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated from graphite fines residues is 73 kg (160 lb).

- **Inorganic Ash—**The largest amount of transuranic waste (over 900 drums) would be generated in the calcine and blend down technology, but the vitrify technology would generate almost as much (almost 800 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than 181 drums. The stabilized residues in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the two technologies under Alternative 4 would each generate over 800 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. No plutonium would be separated from inorganic ash residues under any processing technology.

4.2.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of ash residues. These impacts are presented for incident-free operation and postulated accident scenarios. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship the incinerator ash to the Savannah River Site for Purex processing or mediated electrochemical oxidation/Purex processing, then the number of shipments would be 116 or 86, respectively, and the total round-trip shipping distances would be 607,000 km (376,400 mi) or 450,000 km (279,000 mi), respectively. Shipping the sand, slag, and crucible would require 26 shipments, and the total round-trip shipping distance would be 136,100 km (84,400 mi). Similarly, shipping the graphite fines to the Savannah River Site would require 7 shipments, and the total round-trip shipping distance would be 36,600 km (22,700 mi).

No construction of new processing facilities is required for any of the alternatives at Rocky Flats but DOE may need to modify certain existing facilities and construct new waste storage buildings. For some activities performed at the Savannah River Site, DOE may need to perform decontamination and decommissioning and also modify existing facilities. Mitigation measures during these activities would ensure that only very limited radiological and chemical releases occur. However, workers would be exposed to contaminated materials. Such exposures would be limited to ensure that doses are maintained as low as reasonably achievable.

4.2.2.1 Incident-Free Operations

❒ **Radiological Impacts**

- *Incinerator Ash and Firebrick Fines*—The radiological impacts to the public and the workers associated with incident-free operations of each processing technology for incinerator ash and firebrick fines are presented in **Table 4–6**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–6 is 11 mrem, which could occur only during transportation. This is a bounding estimate of the dose to a maximally exposed individual. It probably exceeds actual potential exposure by a factor of 5. This hypothetical individual's latent cancer fatality risk would be increased by about 5.5×10^{-6}, or less than one chance in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–6 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is approximately 11.6 person-rem, which would cause far less than one additional latent cancer fatality among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose. Estimates of population exposure due to transportation are based on very conservative assumptions designed to overestimate potential risk. See Section E.8 of Appendix E for a discussion of uncertainties and conservatism in the EIS assessment of transportation risk.

  The highest involved worker population radiation dose would be 394 person-rem, which would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. This dose would cause 0.16 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Sand, Slag, and Crucible Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology for sand, slag, and crucible residues are presented in Table 4–6. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing or transportation.

Table 4–6 Radiological Impacts Due to Incident-Free Management of Ash Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem per year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Incinerator Ash and Firebrick Fines								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.00024	1.2×10^{-10}	0.0051	2.6×10^{-6}	2,000	0.0008	376	0.15
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	0.000034	1.7×10^{-11}	0.0014	7.0×10^{-7}	2,000	0.0008	179	0.072
Cold Ceramify at Rocky Flats	0.000038	1.9×10^{-11}	0.0015	7.5×10^{-7}	2,000	0.0008	142	0.057
Calcine and Blend Down at Rocky Flats	0.00019	9.5×10^{-11}	0.0040	2.0×10^{-6}	2,000	0.0008	229	0.092
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	0.000057	2.8×10^{-11}	0.0023	1.2×10^{-6}	2,000	0.0008	145	0.058
Transport to Savannah River Site	11	5.5×10^{-6}	11.4	0.0057	100	0.00004	18	0.0072
Purex at Savannah River Site [a,b]	0.0015	7.5×10^{-10}	0.17	0.000085	2,000	0.0008	231	0.092
Preprocess at Rocky Flats	0.000056	2.8×10^{-11}	0.0023	1.2×10^{-6}	2,000	0.0008	108	0.043
Transport to Savannah River Site	11	5.5×10^{-6}	8.5	0.0042	100	0.00004	13.3	0.0053
Mediated Electrochemical Oxidation/Purex at Savannah River Site [a,b]	0.00079	4.0×10^{-10}	0.088	0.000044	2,000	0.0008	152	0.061
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.00024	1.2×10^{-10}	0.0051	2.6×10^{-6}	2,000	0.0008	320	0.13
Repackage at Rocky Flats	**0.000020**	**1.0×10^{-11}**	**0.00080**	**4.0×10^{-7}**	**2,000**	**0.0008**	**90**	**0.036**
Sand, Slag, and Crucible Residues								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.000035	1.8×10^{-11}	0.00073	3.6×10^{-7}	2,000	0.0008	57	0.023
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	4.6×10^{-6}	2.3×10^{-12}	0.00019	9.5×10^{-8}	2,000	0.0008	25	0.010
Calcine and Blend Down at Rocky Flats	0.000027	1.3×10^{-11}	0.00058	2.9×10^{-7}	2,000	0.0008	32	0.013
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	**2.7×10^{-6}**	**1.4×10^{-12}**	**0.00011**	**5.5×10^{-8}**	**2,000**	**0.0008**	**27**	**0.011**
Transport to Savannah River Site	**11**	**5.5×10^{-6}**	**2.57**	**0.0013**	**100**	**0.00004**	**4**	**0.0016**
Purex at Savannah River Site [a]	**0.00013**	**6.5×10^{-11}**	**0.014**	**7.0×10^{-6}**	**2,000**	**0.0008**	**17**	**0.0068**
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.000036	1.8×10^{-11}	0.00077	3.9×10^{-7}	2,000	0.0008	49	0.020
Repackage at Rocky Flats	2.7×10^{-6}	1.4×10^{-12}	0.00011	5.5×10^{-8}	2,000	0.0008	14	0.0056

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem per year)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Graphite Fines								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.000020	1.0×10^{-11}	0.00042	2.1×10^{-7}	2,000	0.0008	30	0.012
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	2.7×10^{-6}	1.4×10^{-12}	0.00011	5.5×10^{-8}	2,000	0.0008	15	0.0060
Calcine and Blend Down at Rocky Flats	0.000015	7.5×10^{-12}	0.00032	1.6×10^{-7}	2,000	0.0008	18	0.0072
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	4.7×10^{-6}	2.4×10^{-12}	0.00019	9.5×10^{-8}	2,000	0.0008	8.8	0.0035
Transport to Savannah River Site	11	5.5×10^{-6}	0.69	0.00035	100	0.00004	1.1	0.00044
Mediated Electrochemical Oxidation/Purex at Savannah River Site [a, b]	0.000064	3.2×10^{-11}	0.0071	3.6×10^{-6}	2,000	0.0008	12	0.0048
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.000020	1.0×10^{-11}	0.00042	2.1×10^{-7}	2,000	0.0008	26	0.010
Repackage at Rocky Flats	**1.6×10^{-6}**	**8.0×10^{-13}**	**0.000063**	**3.2×10^{-8}**	**2,000**	**0.0008**	**7.3**	**0.0029**
Inorganic Ash								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.000013	6.5×10^{-12}	0.00029	1.4×10^{-7}	2,000	0.0008	26	0.010
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	1.8×10^{-6}	9.0×10^{-13}	0.000076	3.8×10^{-8}	2,000	0.0008	9.8	0.0039
Calcine and Blend Down at Rocky Flats	0.000010	5.2×10^{-12}	0.00023	1.1×10^{-7}	2,000	0.0008	13	0.0052
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.000013	6.5×10^{-12}	0.00029	1.4×10^{-7}	2,000	0.0008	18	0.0072
Repackage at Rocky Flats	**1.1×10^{-6}**	**5.5×10^{-13}**	**0.000044**	**2.2×10^{-8}**	**2,000**	**0.0008**	**5.0**	**0.0020**

[a] Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

[b] If H-Canyon were used, an additional 60 person-rem (with an associated 0.024 latent cancer fatalities) would be received by workers involved with decontamination and decommissioning of highly contaminated equipment prior to installation of two new dissolvers for mediated electrochemical oxidation operations. This 60 person-rem worker population dose when added to the H-Canyon operational worker population dose would be less than the worker population dose associated with total F-Canyon mediated electrochemical oxidation operations for incinerator ash and graphite fines.

Note: The impacts from the preferred processing technology are presented in bold type.

The highest estimated public maximally exposed individual dose in Table 4–6 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent cancer fatality risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–6 would occur if DOE decides to implement the Purex technology at the Savannah River Site. The sum of these doses is approximately 2.6 person-rem, which would cause far less than one additional latent cancer fatality among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose. The highest involved worker population radiation dose would be 57 person-rem, which would occur if DOE decides to implement the No Action calcine, cement, and store technology at Rocky Flats. This dose would cause 0.023 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Graphite Fines*—The radiological impacts to the public and the workers associated with incident-free operations of each technology for graphite fines are presented in Table 4–6. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–6 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent cancer fatality risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–6 would occur if DOE decides to implement the mediated electrochemical oxidation/Purex processing technology at the Savannah River Site. The sum of these doses is approximately 0.70 person-rem, which would cause far less than one additional latent cancer fatality among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 30 person-rem, which would occur if DOE decides to implement the No Action calcine, cement, and store technology at Rocky Flats. This dose would cause 0.012 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Inorganic Ash*—The radiological impacts to the public and the workers associated with incident-free operations of each technology for inorganic ash are presented in Table 4–6. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing.

The highest estimated public maximally exposed individual dose in Table 4–6 is 0.000013 mrem, which would occur during the technology to calcine and cement at Rocky Flats. This hypothetical individual's latent cancer fatality risk would be increased by less than one in one-hundred billion. The highest public population radiation dose listed in Table 4–6 would also occur if DOE decides to implement the calcine and cement technology at Rocky Flats. This dose is 0.00029 person-rem, which would cause far less than one additional latent cancer fatality among the population living near Rocky Flats.

The highest involved worker population radiation dose would be 26 person-rem, which would occur if DOE decides to implement the No Action calcine, cement, and store technology at Rocky Flats. This dose would cause 0.010 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

❒ **Hazardous Chemical Impacts**

- *Incinerator Ash and Firebrick Fines*—The impacts of exposure to hazardous chemicals from the processing and storage of incinerator ash and firebrick fines at Rocky Flats were not evaluated because hazardous chemicals are not expected to be released from the proposed operations at this site.

The processing of incinerator ash and firebrick fines at the Savannah River Site would involve releases of only noncarcinogenic hazardous chemicals. The noncancer health risks for the Purex process and mediated electrochemical oxidation process are the summation of releases of phosphoric acid and ammonium nitrate. The estimated offsite population and noninvolved worker Hazard Index values presented in **Table 4–7** are much less than one, which suggests that noncancer health effects are not expected. The results for the preferred processing technology are presented in bold type. The Hazard Index, which is an estimate of total potential noncancer toxicity, is computed by summing the ratios of the potential airborne concentrations of hazardous chemicals to their chemical-specific toxicity threshold levels (i.e., Reference Concentrations; see Appendix D, Section D.4). Hazard Index values of 1 or more suggest the potential for adverse noncancer health effects following long-term exposure.

- *Sand, Slag, and Crucible Residues*—The processing of sand, slag, and crucible residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

No carcinogenic chemicals would be released from the Purex process at the Savannah River Site. Noncancer health risks resulting from releases of phosphoric acid and ammonium nitrate would notbe expected. Phosphoric acid is a corrosive irritant to the eyes, skin and mucous membranes and a respiratory tract irritant following inhalation exposure (Lewis 1991, EPA 1995a).

- *Graphite Fines*—The processing of graphite fines residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

No carcinogenic chemicals would be released from the mediated electrochemical oxidation process at the Savannah River Site. Noncancer health effects resulting from releases of phosphoric acid and ammonium nitrate would not be expected.

- *Inorganic Ash*—The processing of inorganic ash residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

Table 4–7 Chemical Impacts Due to Incident-Free Management of Ash Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Involved Worker Population*
	Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]	*Probability of Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]
Incinerator Ash and Firebrick Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Cold Ceramify at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.0015 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	1×10^{-9}	N/E	N/E	2×10^{-8}	N/E
Preprocess at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.0011 [c]	N/A	N/A	(c)
Mediated Electrochemical Oxidation/Purex at Savannah River Site [d, e]	N/E	6×10^{-10}	N/E	N/E	8×10^{-9}	N/E
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Sand, Slag, and Crucible Residues						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Transport to Savannah River Site	**N/A**	**N/A**	**0.00034 [c]**	**N/A**	**N/A**	**(c)**
Purex at Savannah River Site [d, e]	**N/E**	**2×10^{-9}**	**N/E**	**N/E**	**2×10^{-8}**	**N/E**
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Involved Worker Population*
	Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]	*Probability of Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]
Graphite Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00009 [c]	N/A	N/A	(c)
Mediated Electrochemical Oxidation/Purex at Savannah River Site [d, e]	N/E	2×10^{-9}	N/E	N/E	2×10^{-8}	N/E
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Inorganic Ash						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**

N/A = Not applicable. The maximally exposed individual is undefined for vehicle emissions. N/E = No emissions.

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from this process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates. See Appendix E, Section E.4 for additional details.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The results for the preferred processing technology are presented in bold type.

4.2.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with ash residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–8**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency by the processing technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–8 for each of the four classes of ash residue. Eight processing technologies are under consideration for the incinerator ash and firebrick fines residue; six processing technolgies are under consideration for the sand, slag, and crucible residue; seven processing technologies are under consideration for the graphite fines residue; and five processing technologies are under consideration for the inorganic ash residue.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–9**, for each processing technology for the four subcategories of ash residue. The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

Table 4–8 Accident Frequencies, Process Durations, and Consequences for Accidents with Ash Residues

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Incinerator Ash and Firebrick Fines									
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	3.00	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	3.00	333	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [c]	0.00005	2.18	480	0.00024	10,000	5.0	8,400	0.0034
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [d]	0.0026	2.18	457	0.00023	9,520	4.8	8,000	0.0032
Cold Ceramify at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.31	762	0.00035	15,900	8.0	13,300	0.0053
Calcine & Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	2.50	667	0.00033	13,900	7.0	11,700	0.0047
	Earthquake (Bldg. 371) [e]	0.000094	2.50	1,000	0.00050	13,900	7.0	11,700	0.0047
Alternative 3 (with Plutonium Separation)									
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.41	1,170	0.00059	24,300	12	20,400	0.016
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	116 shipments	N/A	N/A	N/A	1.0 [f]	N/A	(g)
Purex at Savannah River Site	Earthquake (H-Canyon) [h]	0.000182	15.83	74	0.000037	3,330	1.7	23,600	0.019
Preprocess at Rocky Flats									
Transport to Savannah River Site	Earthquake (Bldg. 707)	0.0026	1.03	1,620	0.00081	33,800	17	28,400	0.023
	Traffic Fatality	0.00010 per shipment	86 shipments	N/A	N/A	N/A	1.0 [f]	N/A	(g)
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	2.16	62	0.000031	2,800	1.4	19,900	0.0080
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	3.00	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	3.00	333	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**1.07**	**1,550**	**0.0078**	**32,300**	**16**	**27,100**	**0.022**
Sand, Slag, and Crucible Residues									
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.42	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.42	333	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [c]	0.00005	0.31	480	0.00024	10,000	5.0	8,400	0.0034
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [d]	0.0026	0.31	457	0.00023	9,520	4.8	8,000	0.0032

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.6	144	0.000072	3,010	1.5	2,530	0.0010
	Earthquake (Bldg. 371) [e]	0.000094	1.6	217	0.00011	3,010	1.5	2,530	0.0010
Alternative 3 (with Plutonium Separation)									
Preprocess at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.31**	**768**	**0.00038**	**16,000**	**8.0**	**13,400**	**0.0054**
Transport to Savannah River Site	**Traffic Fatality**	**0.00010 per shipment**	**26 shipments**	**N/A**	**N/A**	**N/A**	**1.0 [f]**	**N/A**	**(g)**
Purex at Savannah River Site	**Earthquake (H-Canyon) [h]**	**0.000182**	**1.58**	**74**	**0.000037**	**3,330**	**1.7**	**23,600**	**0.019**
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.42	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707)[b]	0.0026	0.42	333	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.15	1,550	0.0078	32,300	16	27,100	0.022
Graphite Fines									
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.24	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.24	333	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [c]	0.00005	0.18	480	0.00024	10,000	5.0	8,400	0.0034
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [d]	0.0026	0.18	457	0.00023	9,520	4.8	8,000	0.0032
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.20	667	0.00033	13,900	7.0	11,700	0.0047
	Earthquake (Bldg. 371) [e]	0.000094	0.20	1,000	0.00050	13,900	7.0	11,700	0.0047
Alternative 3 (with Plutonium Separation)									
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.08	1,620	0.00081	33,800	17	28,400	0.023
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	7 shipments	N/A	N/A	N/A	1.0 [f]	N/A	(g)
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.17	62	0.000031	2,800	1.4	19,900	0.0080
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.24	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.24	333	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.09**	**1,550**	**0.0078**	**32,300**	**16**	**27,100**	**0.022**
Inorganic Ash									

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.17	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.17	533	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)									
	Explosion (Bldg. 707) [c]	0.00005	0.12	480	0.00024	10,000	5.0	8,400	0.0034
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [d]	0.0026	0.12	457	0.00023	9,520	4.8	8,000	0.0032
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.64	144	0.000072	3,010	1.5	2,530	0.0010
	Earthquake (Bldg. 371) [e]	0.000094	0.64	217	0.00011	3,010	1.5	2,530	0.0010
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.17	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.17	533	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0024**	**0.06**	**1,550**	**0.0078**	**32,300**	**16**	**27,100**	**0.022**

N/A =not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 707 is designated as an alternate location for the Calcine and Cement process at Rocky Flats.

[c] Highest consequence accident for this processing technology.

[d] Highest risk accident for this processing technology.

[e] Building 371 is designated as an alternate location for the Calcine and Blend Down process at Rocky Flats.

[f] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list as a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[g] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

[h] HB-Line operates 12.5 percent of the time. Dose estimates assumed the HB-Line was operating at the time of the accident.

Note: The impacts and results for the preferred processing technology are presented in bold type.

Table 4–9 Risks Due to Accidents with Ash Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Incinerator Ash and Firebrick Fines				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	7.1×10^{-8}	0.00098	6.6×10^{-7}
	Composite (Bldg. 371)	1.1×10^{-7}	0.0015	1.0×10^{-6}
	Earthquake (Bldg. 707) [b]	1.3×10^{-6}	0.027	0.000018
	Composite (Bldg. 707) [b]	1.4×10^{-6}	0.028	0.000019
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.3×10^{-6}	0.027	0.000018
	Composite	1.3×10^{-6}	0.028	0.000019
Cold Ceramify at Rocky Flats	Earthquake (Bldg. 707)	1.3×10^{-7}	0.027	0.000018
	Composite	1.3×10^{-6}	0.028	0.000019
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	2.1×10^{-6}	0.045	0.000030
	Composite (Bldg. 707)	2.2×10^{-6}	0.046	0.000031
	Earthquake (Bldg. 371) [c]	1.2×10^{-7}	0.0016	1.1×10^{-6}
	Composite (Bldg. 371) [c]	1.7×10^{-7}	0.0024	1.6×10^{-6}
Alternative 3 (with Plutonium Separation)				
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	2.1×10^{-6}	0.045	0.000060
	Composite	2.2×10^{-6}	0.046	0.000061
Transport to Savannah River Site	Traffic Fatality	N/A	0.012 [d]	N/A
	Radioactive Release	N/A	0.000020	N/A
Purex at Savannah River Site	Earthquake (H-Canyon) [e]	3.5×10^{-8}	0.0016	0.000018
	Composite [e]	6.6×10^{-8}	0.0031	0.000018
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	2.2×10^{-6}	0.045	0.000060
	Composite	2.2×10^{-6}	0.046	0.000061
Transport to Savannah River Site	Traffic Fatality	N/A	0.0088 [d]	N/A
	Radioactive Release	N/A	0.000020	N/A
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon)	1.2×10^{-8}	0.00055	3.1×10^{-6}
	Composite	2.0×10^{-8}	0.00094	3.2×10^{-6}

	Accident Scenario	Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)	Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)
Alternative 4 (Combination)				
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	7.1×10^{-8}	0.00098	6.6×10^{-7}
	Composite (Bldg. 371)	1.1×10^{-7}	0.0015	1.0×10^{-6}
	Earthquake (Bldg. 707) [b]	1.3×10^{-6}	0.027	0.000018
	Composite (Bldg. 707) [b]	1.4×10^{-6}	0.028	0.000019
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**2.2×10^{-6}**	**0.045**	**0.000060**
	Composite	**2.2×10^{-6}**	**0.046**	**0.000061**
Sand, Slag, and Crucible Residues				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	9.9×10^{-9}	0.00014	9.2×10^{-8}
	Composite (Bldg. 371)	1.5×10^{-8}	0.00021	1.4×10^{-7}
	Earthquake (Bldg. 707) [b]	1.8×10^{-7}	0.0038	2.5×10^{-6}
	Composite (Bldg. 707) [b]	1.9×10^{-7}	0.0040	2.7×10^{-6}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.8×10^{-7}	0.0038	2.6×10^{-6}
	Composite	1.9×10^{-7}	0.0040	2.7×10^{-6}
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	3.0×10^{-7}	0.0063	4.2×10^{-6}
	Composite (Bldg. 707)	3.3×10^{-7}	0.0069	4.6×10^{-6}
	Earthquake (Bldg. 371) [c]	1.6×10^{-8}	0.00023	1.5×10^{-7}
	Composite (Bldg. 371) [c]	2.7×10^{-8}	0.00038	2.6×10^{-7}
Alternative 3 (with Plutonium Separation)				
Preprocess at Rocky Flats	**Earthquake (Bldg. 707)**	**3.1×10^{-7}**	**0.0064**	**4.3×10^{-6}**
	Composite	**3.2×10^{-7}**	**0.0066**	**4.5×10^{-6}**
Transport to Savannah River Site	**Traffic Fatality**	**N/A**	**0.0027 [d]**	**N/A**
	Radioactive Release	**N/A**	**2.9×10^{-7}**	**N/A**
Purex at Savannah River Site	**Earthquake (H-Canyon) [e]**	**3.5×10^{-9}**	**0.00016**	**1.8×10^{-6}**
	Composite [e]	**6.6×10^{-9}**	**0.00030**	**1.8×10^{-6}**
Alternative 4 (Combination)				
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	9.9×10^{-9}	0.00014	9.2×10^{-8}
	Composite (Bldg. 371)	1.5×10^{-8}	0.00021	1.4×10^{-7}
	Earthquake (Bldg. 707)[b]	1.8×10^{-7}	0.0038	2.5×10^{-6}
	Composite (Bldg. 707)[b]	1.9×10^{-7}	0.0040	2.7×10^{-6}

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Repackage at Rocky Flats	Earthquake (Bldg. 707)	3.0×10^{-7}	0.0063	8.5×10^{-6}
	Composite (Bldg. 707)	3.1×10^{-7}	0.0064	8.6×10^{-6}
Graphite Fines				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	5.6×10^{-9}	0.000078	5.3×10^{-8}
	Composite (Bldg. 371)	8.6×10^{-9}	0.00012	8.0×10^{-8}
	Earthquake (Bldg. 707) [b]	1.0×10^{-7}	0.0022	1.5×10^{-6}
	Composite (Bldg. 707) [b]	1.1×10^{-7}	0.0023	1.5×10^{-6}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.1×10^{-7}	0.0022	1.5×10^{-6}
	Composite	1.1×10^{-7}	0.0023	1.6×10^{-6}
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	1.7×10^{-7}	0.0036	2.4×10^{-6}
	Composite (Bldg. 707)	1.8×10^{-7}	0.0037	2.5×10^{-6}
	Earthquake (Bldg. 371) [c]	9.4×10^{-9}	0.00013	8.8×10^{-8}
	Composite (Bldg. 371) [c]	1.4×10^{-8}	0.00019	1.3×10^{-7}
Alternative 3 (with Plutonium Separation)				
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	1.7×10^{-7}	0.0035	4.7×10^{-6}
	Composite	1.7×10^{-7}	0.0036	4.8×10^{-6}
Transport to Savannah River Site	Traffic Fatality	N/A	0.0007 [b]	N/A
	Radioactive Release	N/A	1.6×10^{-7}	N/A
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon)	9.6×10^{-10}	0.000043	2.5×10^{-7}
	Composite	1.6×10^{-9}	0.000074	2.5×10^{-7}
Alternative 4 (Combination)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	5.6×10^{-9}	0.000078	5.3×10^{-8}
	Composite (Bldg. 371)	8.6×10^{-9}	0.00012	8.0×10^{-8}
	Earthquake (Bldg. 707) [b]	1.0×10^{-7}	0.0022	1.5×10^{-6}
	Composite (Bldg. 707) [b]	1.1×10^{-7}	0.0023	1.5×10^{-6}
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**1.8×10^{-7}**	**0.0038**	**5.1×10^{-6}**
	Composite	**1.9×10^{-7}**	**0.0039**	**5.1×10^{-6}**

	Accident Scenario	Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)	Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)
Inorganic Ash				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	4.0×10^{-9}	0.000055	3.7×10^{-8}
	Composite (Bldg. 371)	6.1×10^{-9}	0.000084	5.7×10^{-8}
	Earthquake (Bldg. 707) [b]	7.4×10^{-8}	0.0015	1.0×10^{-6}
	Composite (Bldg. 707) [b]	7.7×10^{-8}	0.0016	1.1×10^{-6}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	7.1×10^{-8}	0.0015	1.0×10^{-6}
	Composite	7.4×10^{-8}	0.0015	1.0×10^{-6}
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	1.2×10^{-7}	0.0025	1.7×10^{-6}
	Composite (Bldg. 707)	1.3×10^{-7}	0.0027	1.8×10^{-6}
	Earthquake (Bldg. 371) [c]	6.5×10^{-9}	0.000090	6.1×10^{-8}
	Composite (Bldg. 371) [c]	1.1×10^{-8}	0.00015	1.0×10^{-7}
Alternative 4 (Combination)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	4.0×10^{-9}	0.000055	3.7×10^{-8}
	Composite (Bldg. 371)	6.1×10^{-9}	0.000084	5.7×10^{-8}
	Earthquake (Bldg. 707) [b]	7.4×10^{-8}	0.0015	1.0×10^{-6}
	Composite (Bldg. 707) [b]	7.7×10^{-8}	0.0016	1.1×10^{-6}
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**1.2×10^{-7}**	**0.0025**	**3.4×10^{-6}**
	Composite	**1.2×10^{-7}**	**0.0026**	**3.4×10^{-6}**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 707 is designated as an alternate location for the Calcine and Cement process at Rocky Flats.

[c] Building 371 is designated as an alternate location for the Calcine and Blend Down process at Rocky Flats.

[d] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

[e] The H-Canyon operates 100 percent of the time and the HB-Line operates 12.5 percent of the time.

Note: The risks due to the preferred processing technology are presented in bold type.

- *Incinerator Ash and Firebrick Fines*—Highest consequences to all three receptors would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site and a major earthquake strong enough to cause the collapse of Building 707 occurs during the preprocessing of residues to be shipped to the Savannah River Site for final processing.

  The highest risk to the public maximally exposed individual is estimated to be 2.2×10^{-6}, which is due to an earthquake during preprocessing of the residue at Rocky Flats for the mediated electrochemical oxidation technology at the Savannah River Site, or an earthquake during repackaging the residue with the Repackaging technology at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand. The highest risk to the public population is estimated to be 0.045 latent cancer fatalities, which is due to an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the mediated electrochemical oxidation technology at the Savannah River Site, an earthquake during processing the residue with the calcine and blend down technology in Rocky Flats Building 707, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the Purex technology at the Savannah River Site, or an earthquake during repackaging the residue at Rocky Flats. The highest risk to the individual noninvolved onsite worker is estimated to be 0.000060, which is due to an earthquake during preprocessing of the residue at Rocky Flats for the Purex technology at the Savannah River Site or an earthquake during preprocessing of the residue at Rocky Flats for the mediated electrochemical oxidation technology at the Savannah River Site, or an earthquake during repackaging the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand.

- *Sand, Slag, and Crucible Residues*—The highest consequence to all three receptors would occur if DOE decides to implement the Repackage technology at Rocky Flats and a major earthquake strong enough to cause the breach of Building 707 occurs.

  The highest risk to the public maximally exposed individual is estimated to be 3.1×10^{-7}, which is due to an earthquake during preprocessing of the residue at Rocky Flats for the Purex technology at the Savannah River Site. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.0064 latent cancer fatalities, which is also due to an earthquake during repackaging the residue at Rocky Flats. The highest risk to the individual noninvolved onsite worker is estimated to be 8.5×10^{-6}, which is due to an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

- *Graphite Fines*—The highest consequences to all three receptors would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site and a major earthquake strong enough to cause the collapse of Building 707 occurs during the preprocessing of residues to be shipped to the Savannah River Site for final processing.

  The highest risk to the public maximally exposed individual is estimated to be 1.8×10^{-7}, which is due to an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.0038 latent cancer fatalities, which is also due to an earthquake during repackaging of the residue at Rocky Flats. The highest risk to the individual noninvolved onsite worker is estimated to be 5.1×10^{-6}, which is also due to an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a hundred thousand.

- *Inorganic Ash* —The highest consequences to all three receptors would occur if DOE decides to implement the Repackage technology at Rocky Flats and a major earthquake strong enough to cause the breach of Building 707 occurs.

  The highest risk to the public maximally exposed individual is estimated to be 1.2×10^{-7}, which is due to an earthquake during processing of the residue with the calcine and blend down technology in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a million. The highest risk to the public population is estimated to be 0.0025 latent cancer fatalities, which is due to the same earthquake-initiated accident described for the maximally exposed individual. The highest risk to the individual noninvolved onsite worker is estimated to be 3.4×10^{-6}, which is due to an earthquake during repackaging of the residue in Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

4.3 IMPACTS OF MANAGING PYROCHEMICAL SALT RESIDUES

The inventory of pyrochemical salt residues assessed in this EIS is divided into four subcategories, as shown in **Table 4-10**. The inventory of pyrochemical salt residues weights 14,888 kg (32,822 lb), including 1,002 kg (2,209 lb) of plutonium. This inventory is stored in 628 drums (with approximately 3,140 internal metal containers) and 2,957 other small individual containers.

Table 4–10 Pyrochemical Salt Residues

Salt Subcategories	*Residue Mass (kg)*[a]	*Plutonium Mass (kg)*[a]	*Number of Drums*	*Number of Other Individual Containers*
IDC 409	1,474	237	272	24
Other ER/MSE	11,243	575	276	2,416
IDC 365, 413, 427	727	139	35	365
Other DOR	1,444	51	45	152
Totals	14,888	1,002	628	2,957

[a] To convert to pounds, multiply by 2.2.

All four subcategories of salt residues have the same technology options under the No Action Alternative: to pyro-oxidize and store the residue at Rocky Flats. Similarly, all four subcategories have the same processing technology under the Process without Plutonium Separation Alternative: to pyro-oxidize and blend down the residue. The technologies within the Process with Plutonium Separation Alternative are more complicated. These technologies include two technologies at Rocky Flats, three at Los Alamos, and one at the Savannah River Site. All four subcategories have the same processing technology under Alternative 4. The preferred processing technology for all salt residues except the IDC 365, 413, and 427 residues is repackaging at Rocky Flats. As discussed in Section 2.4.2, there are two preferred processing technologies for these residues: (1) acid dissolution at Los Alamos National Laboratory and (2) repackaging at Rocky Flats.

Any plutonium separated by the salt distillation or water leach processes would contain americium, while any plutonium separated by the acid dissolution or Purex processes would not. Americium emits gamma radiation, which would increase the worker doses. In the acid dissolution process at Los Alamos National Laboratory, the americium would be stabilized as transuranic waste. It would be stored at Los Alamos National Laboratory pending disposal at WIPP. In the Purex process at the Savannah River Site, the americium would go into the high-level waste. The impacts in this section take into account the gamma radiation from americium.

This section presents the environmental impacts of managing the entire inventory of each subcategory under each of the technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.3.1 Products and Wastes

Every processing technology for pyrochemical salt residues would generate some quantity of transuranic waste and thus would involve preparation of this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone would be generated only at the Savannah River Site if the scrub alloy resulting from salt scrubbing at Rocky Flats were shipped to that site for plutonium separation. The final form for the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a by-product of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults.

If plutonium is separated at Rocky Flats, the Savannah River Site, or Los Alamos National Laboratory, it would be stored securely until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes.

The solid plutonium-bearing products and wastes that would be generated from pyrochemical salt residues under each of the technologies are presented in **Table 4–11.** The shaded areas of Table 4–11 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technologies are presented in bold type. The stabilized residues from the No Action Alternative could actually be stored in small metal containers in a vault, but for the purpose of comparisons in this EIS, DOE considered that these stabilized residues would be stored in drums like the rest of the stabilized residues.

- **IDC 409 Salt Residues—**The largest amount of transuranic waste (over 1,600 drums) would be generated in the water leach technology at Rocky Flats, but the pyro-oxidize and blend down technology at Rocky Flats would generate almost as much (over 1,400 drums). The amount of waste from the water leach process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. The amount of waste from the pyro-oxidize and blend down process is high because blending down requires a large volume increase. These two technologies would generate much more transuranic waste than the other technologies, which would generate fewer than 200 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate 1,500 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste

are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from IDC 409 salt residues is 235 kg (518 lb).

Table 4–11 Products and Wastes from Pyrochemical Salt Residues

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
IDC 409 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	1,406	90			157	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		1,445			157	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats		97		235	157	
Pyro-Oxidize and Water Leach at Rocky Flats		1,609		228	3,665	
Pyro-Oxidize at Rocky Flats		90		–	157	
Salt Distill at Los Alamos National Laboratory		85		234	106	
Salt Scrub at Rocky Flats		180	–	–	157	–
Purex at Savannah River Site		11	0.1	228	41	51
Alternative 4 (Combination)						
Repackage at Rocky Flats	**1,410**[d]	**90**			**157**	
Other Electrorefining and Molten Salt Extraction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	3,800	464			842	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		10,802			842	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats		519		569	842	
Pyro-Oxidize and Water Leach at Rocky Flats		11,945		552	27,600	
Pyro-Oxidize at Rocky Flats		464		–	842	
Salt Distill at Los Alamos National Laboratory		469		558	818	
Salt Scrub at Rocky Flats		1,152	–	–	842	–
Purex at Savannah River Site		84	1	553	309	384
Alternative 4 (Combination)						
Repackage at Rocky Flats	**3,800**[d]	**464**			**842**	

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
IDC 365, 413, and 427 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	583	40			58	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		708			58	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats		792		133	1,788	
Pyro-Oxidize at Rocky Flats		**40**		**–**	**58**	
Acid Dissolve at Los Alamos National Laboratory		**825**		**138**	**1,797**	
Pyro-Oxidize at Rocky Flats		40		–	58	
Water Leach at Los Alamos National Laboratory		807		138	1,797	
Salt Scrub at Rocky Flats		84	–	–	58	–
Purex at Savannah River Site		5	0.1	134	20	25
Alternative 4 (Combination)						
Repackage at Rocky Flats	**826**[d]	**40**			**58**	
Other Direct Oxide Reduction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	306	56			110	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		1,384			110	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats		1,550		49	3,547	
Pyro-Oxidize at Rocky Flats		56		–	110	
Acid Dissolve at Los Alamos National Laboratory		1,581		50	3,439	
Pyro-Oxidize at Rocky Flats		56		–	110	
Water Leach at Los Alamos National Laboratory		1,557		50	3,439	
Salt Scrub at Rocky Flats		145	–	–	110	–
Purex at Savannah River Site		11	0.1	49	40	50
Alternative 4 (Combination)						
Repackage at Rocky Flats	**306**[d]	**56**			**110**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technologies are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table, except as noted in the text.

- **Other Electrorefining and Molten Salt Extraction Salt Residues—**The largest amount of transuranic waste (almost 12,000 drums) would be generated in the water leach technology at Rocky Flats, but the pyro-oxidize and blend down technology at Rocky Flats would generate almost as much (almost 11,000 drums). The amount of waste from the water leach process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. The amount of waste from the pyro-oxidize and blend down process is high because blending down requires a large volume increase. These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than about 1,100 drums. These two processing technologies would also stress the capacity for transuranic waste storage at Rocky Flats. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate over 4,000 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from other electrorefining and molten salt extraction pyrochemical salt residues is 569 kg (1,254 lb).

- **IDC 365, 413 and 427 Salt Residues—**Four of the seven processing technologies would cause over 700 drums of transuranic waste to be generated. In the other three technologies, fewer than 100 drums of transuranic waste would be generated. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate over 850 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from these salt residues is 138 kg (304 lb).

- **Other Direct Oxide Reduction Salt Residues—**Four of the seven processing technologies would cause over 1,300 drums of transuranic waste to be generated. In the other three technologies, fewer than 200 drums of transuranic waste would be generated. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate over 350 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from other direct oxide reduction salt residues is 50 kg (110 lb).

4.3.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of salt residues. These impacts are presented for incident-free operation and postulated accident scenarios. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship scrub alloy from the IDC 409 salt residues to the Savannah River Site for Purex processing, then seven shipments would be required and the total round-trip shipping distance would be 36,600 km (22,700 mi). If DOE decides to ship scrub alloy from the other electrorefining and molten salt extraction salt residues to the Savannah River Site for Purex processing, then 15 shipments would be required and the total round-trip shipping distance would be 78,500 km (48,700 mi). Shipping scrub alloy from the IDC 365, 413, and 427 salt residues to the Savannah River Site would require three shipments, and the total round-trip shipping distance would be 15,700 km (9,700 mi). Similarly, shipping scrub alloy from the other direct oxide

reduction salt residues to the Savannah River Site would require one shipment, and the total round-trip shipping distance would be 5,200 km (3,200 mi).

The round-trip highway distance from Rocky Flats to the Los Alamos National Laboratory is 1,468 km (910 mi). If DOE decides to ship the IDC 409 residues to the Los Alamos National Laboratory for processing, then six shipments would be required and the total round-trip shipping distance would be 8,800 km (5,500 mi). If DOE decides to ship the other electrorefining and molten salt extraction salt residues to the Los Alamos National Laboratory for processing, then 44 shipments would be required and the total round-trip shipping distance would be 64,600 km (40,000 m i). Shipping IDC 365, 413, and 427 salt residues to the Los Alamos National Laboratory would require three shipments, and the total round-trip shipping distance would be 4,400 km (2,700 mi). Shipping the other direct oxide reduction salt residues to the Los Alamos National Laboratory would require ten shipments, and the total round-trip shipping distance would be 14,700 km (9,100 mi).

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.3.2.1 Incident-Free Operations

❒ **Radiological Impacts**

- *IDC 409 Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4-12**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is 0.72 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 194 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.078 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

Table 4–12 Radiological Impacts Due to Incident-Free Management of Pyrochemical Salt Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem/ yr)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
IDC 409 Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	0.000012	6.0×10^{-12}	0.00050	2.5×10^{-7}	2,000	0.0008	104	0.042
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	0.000018	9.0×10^{-12}	0.00073	3.7×10^{-7}	2,000	0.0008	194	0.078
Alternative 3 (with Plutonium Separation)								
Salt Distill at Rocky Flats	0.000022	1.1×10^{-11}	0.00088	4.4×10^{-7}	2,000	0.0008	61	0.024
Water Leach at Rocky Flats	0.00011	5.5×10^{-11}	0.0027	1.4×10^{-6}	2,000	0.0008	143	0.057
Pyro-Oxidize at Rocky Flats	9.9×10^{-6}	5.0×10^{-12}	0.00040	2.0×10^{-7}	2,000	0.0008	26	0.010
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.16	0.000080	100	0.00004	0.25	0.00010
Salt Distill at Los Alamos National Laboratory	0.00012	6.0×10^{-11}	0.00035	1.8×10^{-7}	2,000	0.0008	18	0.0072
Salt Scrub at Rocky Flats	0.000018	9.0×10^{-12}	0.00073	3.7×10^{-7}	2,000	0.0008	54	0.022
Transport to Savannah River Site	11	5.5×10^{-6}	0.69	0.00035	100	0.00004	1.1	0.00044
Purex at Savannah River Site[b]	0.00027	1.4×10^{-10}	0.029	0.000015	2,000	0.0008	28	0.011
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0.000020**	**1.0×10^{-11}**	**0.00081**	**4.1×10^{-7}**	**2,000**	**0.0008**	**48**	**0.019**
Other Electrorefining and Molten Salt Extraction Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	0.000026	1.3×10^{-11}	0.0011	5.5×10^{-7}	2,000	0.0008	231	0.092
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	0.000043	2.2×10^{-11}	0.0018	9.0×10^{-7}	2,000	0.0008	470	0.19
Alternative 3 (with Plutonium Separation)								
Salt Distill at Rocky Flats	0.000052	2.6×10^{-11}	0.0021	1.1×10^{-6}	2,000	0.0008	148	0.059
Water Leach at Rocky Flats	0.00028	1.4×10^{-10}	0.0064	3.2×10^{-6}	2,000	0.0008	346	0.14
Pyro-Oxidize at Rocky Flats	0.000025	1.3×10^{-11}	0.0011	5.5×10^{-7}	2,000	0.0008	117	0.047
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	1.2	0.00060	100	0.00004	1.8	0.00072
Salt Distill at Los Alamos National Laboratory	0.00031	1.6×10^{-10}	0.00092	4.6×10^{-7}	2,000	0.0008	116	0.046
Salt Scrub at Rocky Flats	0.000043	2.2×10^{-11}	0.0018	9.0×10^{-7}	2,000	0.0008	131	0.052
Transport to Savannah River Site	11	5.5×10^{-6}	1.5	0.00075	100	0.00004	2.3	0.00092
Purex at Savannah River Site[a]	0.00066	3.3×10^{-10}	0.070	0.000035	2,000	0.0008	69	0.028
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0.000026**	**1.3×10^{-11}**	**0.0011**	**5.5×10^{-7}**	**2,000**	**0.0008**	**182**	**0.073**

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem/ yr)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
IDC 365, 413 and 427 Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	7.0×10^{-6}	3.6×10^{-12}	0.00029	1.5×10^{-7}	2,000	0.0008	57	0.023
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	0.000010	5.0×10^{-12}	0.00043	2.2×10^{-7}	2,000	0.0008	113	0.045
Alternative 3 (with Plutonium Separation)								
Water Leach at Rocky Flats	0.00011	5.5×10^{-11}	0.0023	1.2×10^{-6}	2,000	0.0008	84	0.034
Pyro-Oxidize at Rocky Flats	**0.000011**	**5.5×10^{-12}**	**0.00045**	**2.3×10^{-7}**	**2,000**	**0.0008**	**9.8**	**0.0039**
Transport to Los Alamos National Laboratory	**11**	**5.5×10^{-6}**	**0.082**	**0.000041**	**100**	**0.00004**	**0.12**	**0.000048**
Acid Dissolve at Los Alamos National Laboratory	**0.00027**	**1.4×10^{-10}**	**0.00079**	**4.0×10^{-7}**	**2,000**	**0.0008**	**8.8**	**0.0035**
Pyro-Oxidize at Rocky Flats	0.000010	5.0×10^{-12}	0.00040	2.0×10^{-7}	2,000	0.0008	9.8	0.0039
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.082	0.000041	100	0.00004	0.12	0.000048
Water Leach at Los Alamos National Laboratory	0.000061	3.1×10^{-11}	0.00018	9.0×10^{-8}	2,000	0.0008	4.8	0.0019
Salt Scrub at Rocky Flats	0.000010	5.0×10^{-12}	0.00042	2.1×10^{-7}	2,000	0.0008	14	0.0056
Transport to Savannah River Site	11	5.5×10^{-6}	0.30	0.00015	100	0.00004	0.47	0.00019
Purex at Savannah River Site [a]	0.00016	8.0×10^{-11}	0.017	8.5×10^{-6}	2,000	0.0008	17	0.0068
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0.000022**	**1.1×10^{-11}**	**0.00089**	**4.5×10^{-7}**	**2,000**	**0.0008**	**28**	**0.011**
Other Direct Oxide Reduction Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	2.5×10^{-6}	1.3×10^{-12}	0.00010	5.0×10^{-8}	2,000	0.0008	40	0.016
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	42	0.017
Alternative 3 (with Plutonium Separation)								
Water Leach at Rocky Flats	0.000040	2.0×10^{-11}	0.00083	4.2×10^{-7}	2,000	0.0008	31	0.012
Pyro-Oxidize at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00015	7.5×10^{-8}	2,000	0.0008	19	0.0076
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.27	0.00014	100	0.00004	0.42	0.00017
Acid Dissolve at Los Alamos National Laboratory	0.000099	5.0×10^{-11}	0.00029	1.5×10^{-7}	2,000	0.0008	17	0.0068
Pyro-Oxidize at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00015	7.5×10^{-8}	2,000	0.0008	19	0.0076
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.27	0.00014	100	0.00004	0.42	0.00017
Water Leach at Los Alamos National Laboratory	0.000022	1.1×10^{-11}	0.000064	3.2×10^{-8}	2,000	0.0008	9.4	0.0038
Salt Scrub at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	29	0.012
Transport to Savannah River Site	11	5.5×10^{-6}	0.10	0.000050	100	0.00004	0.16	0.000064
Purex at Savannah River Site[a]	0.000059	3.0×10^{-11}	0.0062	3.1×10^{-6}	2,000	0.0008	6.2	0.0025
Alternative 4 (Combination)								
Repackage at Rocky Flats	**2.5×10^{-6}**	**1.3×10^{-12}**	**0.00010**	**5.0×10^{-8}**	**2,000**	**0.0008**	**36**	**0.014**

[a]Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.
Note: The impacts due to the preferred processing technology are presented in bold type.

- *Other Electrorefining and Molten Salt Extraction Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in Table 4–12. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of electrorefining and molten salt extraction salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is 1.6 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 470 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.19 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *IDC 365, 413, and 417 Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in Table 4–12. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is 0.32 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sides and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 113 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.045 additional latent cancer fatalities among the workers directly involved in the

operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Other Direct Oxide Reduction Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in Table 4–12. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of direct oxide reduction salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the acid dissolve technology at the Los Alamos National Laboratory. The sum of these doses is 0.27 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sides and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 42 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.017 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

❒ **Hazardous Chemical Impacts—**The impacts of exposure to hazardous chemicals from the processing and storage of pyrochemical salt residues at Rocky Flats and at the Los Alamos National Laboratory were not evaluated. Hazardous chemicals are not expected to be released from the proposed operations at these sites.

The processing at the Savannah River Site of the scrub alloy that results from salt scrubbing at Rocky Flats would involve releases of only noncarcinogenic hazardous chemicals. The estimated offsite population and noninvolved worker Hazard Index values presented in **Table 4–13** are much less than one, which suggests that noncancer health effects as a result of releases of phosphoric acid and ammonium nitrate would not be expected. The impacts due to the preferred processing technology are presented in bold type.

4.3.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with pyrochemical salt residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected

and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risk due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of

Table 4–13 Chemical Impacts Due to Incident-Free Management of Pyrochemical Salt Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of a Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]	*Probability of a Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]
IDC 409 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00003 [c]	N/A	N/A	(c)
Salt Distill at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00009 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	5×10^{-10}	N/E	N/E	5×10^{-9}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Other Electrorefining and Molten Salt Extraction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00020 [c]	N/A	N/A	(c)
Salt Distill at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00020 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	1×10^{-9}	N/E	N/E	1×10^{-8}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
IDC 365, 413 and 427 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E

	Offsite Public Maximally Exposed Individual		Offsite Public Population	Maximally Exposed Individual Worker		Worker Population
	Probability of a Cancer Incidence	Hazard Index	Number of Cancer Incidences or Fatalities [a]	Probability of a Cancer Incidence	Hazard Index	Number of Cancer Incidences or Fatalities [a]
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Transport to Los Alamos National Laboratory	**N/A**	**N/A**	**0.00001 [c]**	**N/A**	**N/A**	**(c)**
Acid Dissolve at Los Alamos National Laboratory [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00001 [c]	N/A	N/A	(c)
Water Leach at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00004 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	3×10^{-10}	N/E	N/E	3×10^{-9}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Other Direct Oxide Reduction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00005 [c]	N/A	N/A	(c)
Acid Dissolve at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00005 [c]	N/A	N/A	(c)
Water Leach at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00001 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	1×10^{-10}	N/E	N/E	1×10^{-9}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**

N/E = no emissions N/A = not applicable—the maximally exposed individual is undefined for vehicle emissions

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively. However, the risk to the public dominates. See Appendix E, Section E.4 for additional details.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The impacts due to the preferred processing technology are presented in bold type.

comparing processing technologies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–14**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. Impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site or to Los Alamos National Laboratory, as appropriate. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–14, for each of the four classes of salt residues. Six processing technologies are under consideration for the IDC 409 salt residues; eight processing technologies are under consideration for the other electrorefining and molten salt extraction salt residues; six processing technologies are under consideration for the IDC 365, 413 and 427 salt residues; and eight processing technologies are under consideration for the other direct oxide reduction salt residues.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–15**, for each of the processing technologies for pyrochemical salt residue. The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

- **IDC 409 Salt Residues—**The highest consequence to all three receptors would occur if DOE decides to implement the repackage technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707 occurs.

  The highest risk to the public maximally exposed individual is estimated to be 0.000015 and would occur due to an earthquake during repackaging of the residue in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The highest risk to the public population is estimated at 0.13 and would occur due to an earthquake strong enough to collapse Rocky Flats Building 707. The highest risk to the noninvolved worker is estimated to be 0.00014 and would occur due to either an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and salt distill technology at Rocky Flats, or an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the salt distillation technology at Los Alamos

National Laboratory. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand.

Table 4–14 Accident Frequencies, Process Durations, and Consequences for Accidents with Pyrochemical Salt Residues

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
IDC 409 Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	0.95	6,080	0.0030	106,000	53	68,400	0.055
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	2.76	2,090	0.0010	36,600	18	23,500	0.019
	Earthquake (Bldg. 371) [b]	0.000094	2.76	3,140	0.0016	36,600	18	23,500	0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.64	9,000	0.0045	158,000	79	101,000	0.081
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	0.000094	0.56	15,500	0.0078	181,000	91	116,000	0.093
	Earthquake (Bldg 707A) [d]	0.0026	0.42	12,200	0.0061	227,000	114	148,000	0.12
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.67	8,640	0.0043	151,000	76	97,200	0.078
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	N/A	N/A	N/A	N/A	1.0[e]	N/A	(f)
Salt Distill at Los Alamos National Laboratory	Earthquake	0.0005	1.77	15,400	0.0077	20,200	1.0	166,000	0.13
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.38	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	7 shipments	N/A	N/A	N/A	1.0[e]	N/A	(f)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.53	407	0.00020	18,100	9.1	136,000	0.11
Alternative 4 (Combination)									
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.28**	**20,300**	**0.020**	**356,000**	**178**	**229,000**	**0.18**
Other Electrorefining and Molten Salt Extraction Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	2.30	6,080	0.0030	106,000	53	68,400	0.055
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	6.70	2,090	0.0011	36,600	18	23,500	0.019
	Earthquake (Bldg. 371) [b]	0.000094	6.70	3,140	0.0016	36,600	18	23,500	0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.56	9,000	0.0045	158,000	79	101,000	0.081
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	0.000094	1.34	15,500	0.0078	181,000	91	116,000	0.093
	Earthquake (Bldg 707A) [d]	0.0026	1.01	12,200	0.0061	227,000	114	148,000	0.12

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.62	8,640	0.0043	151,000	76	97,200	0.078
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	44 shipments	N/A	N/A	N/A	1.0[e]	N/A	(f)
Salt Distill at Los Alamos National Laboratory	Earthquake	0.0005	4.28	15,400	0.0077	20,200	10	166,000	0.13
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.91	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	15 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	1.29	407	0.00020	18,100	9.1	136,000	0.11
Alternative 4 (Combination)									
Repackage at Rocky Flats	Earthquake (Bldg. 707)	0.0026	2.30	6,080	0.0030	106,000	53	68,400	0.055
IDC 365, 413 and 427 Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	1.00	3,390	0.0017	59,300	30	38,100	0.030
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.62	2,090	0.0011	36,600	18	23,500	0.019
	Earthquake (Bldg. 371) [f]	0.000094	1.62	3,140	0.0016	36,600	18	23,500	0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [b]	0.000094	0.33	15,500	0.0078	181,000	91	116,000	0.093
	Earthquake (Bldg 707A) [c]	0.0026	0.25	12,200	0.0061	227,000	114	148,000	0.12
Pyro-Oxidize at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.41**	**8,310**	**0.0042**	**145,000**	**73**	**93,500**	**0.075**
Transport to Los Alamos National Laboratory	**Traffic Fatality**	**2.9×10^{-5} per shipment**	**3 shipments**	**N/A**	**N/A**	**N/A**	**1.0 [e]**	**N/A**	**(f)**
Acid Dissolve at Los Alamos National Laboratory	**Earthquake**	**0.0005**	**0.64**	**12,300**	**0.0062**	**16,200**	**8.1**	**133,000**	**0.11**
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.41	8,310	0.0042	145,000	73	93,500	0.075
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	3 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Water Leach at Los Alamos National Laboratory	Earthquake	0.0005	0.64	12,300	0.0062	16,200	8.1	133,000	0.11
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.22	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	3 shipments	N/A	N/A	N/A	1.0[c]	N/A	(f)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.31	407	0.00020	18,100	9.1	136,000	0.11

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Alternative 4 (Combination)									
Repackage at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.17	20,300	0.020	356,000	178	229,000	0.18

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Other Direct Oxide Reduction Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	0.37	3,390	0.0017	59,300	30	38,100	0.030
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.60	2,090	0.0011	36,600	18	23,500	0.019
	Earthquake (Bldg. 371) [f]	0.000094	0.60	3,140	0.0016	36,600	18	23,500	0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [b]	0.000094	0.12	15,500	0.0078	181,000	91	116,000	0.093
	Earthquake (Bldg 707A) [c]	0.00026	0.94	12,200	0.0061	227,000	114	148,000	0.12
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.15	8,310	0.0042	145,000	73	93,500	0.075
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	10 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Acid Dissolve at Los Alamos National Laboratory	Earthquake	0.0005	0.24	12,300	0.0062	16,200	8.1	133,000	0.11
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.15	8,310	0.0042	145,000	73	93,500	0.075
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	10 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Water Leach at Los Alamos National Laboratory	Earthquake	0.0005	0.30	15,100	0.0076	19,800	9.9	163,000	0.13
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.08	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	1 shipment	N/A	N/A	N/A	1.0 [d]	N/A	(e)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.12	407	0.00020	18,100	9.1	136,000	0.11
Alternative 4 (Combination)									
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.37**	**3,390**	**0.0017**	**59,300**	**30**	**38,100**	**0.030**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 371 is designated as an alternate location for the Pyro-Oxidize and Blend Down process at Rocky Flats

[c] Water Leach process in Building 371.

[d] Final calcination process in Building 707A.

[e] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list in a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[f] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–15 Risks Due to Accidents with Pyrochemical Salt Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
IDC 409 Salt Residues				
Alternative 1 (No Action)				
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00013
	Composite	7.6×10^{-6}	0.13	0.00014
Alternative 2 (without Plutonium Separation)				
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00013
	Composite (Bldg. 707)	7.6×10^{-6}	0.13	0.00014
	Earthquake (Bldg. 371) [b]	4.1×10^{-7}	0.0047	4.9×10^{-6}
	Composite (Bldg. 371) [b]	5.7×10^{-7}	0.0067	5.9×10^{-6}
Alternative 3 (with Plutonium Separation)				
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00014
	Composite	7.6×10^{-6}	0.13	0.00014
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	4.1×10^{-7}	0.0048	4.9×10^{-6}
	Composite (Bldg. 371) [c]	5.9×10^{-7}	0.0069	5.9×10^{-6}
	Earthquake (Bldg. 707A) [d]	6.7×10^{-6}	0.12	0.00013
	Composite (Bldg. 707A) [d]	6.8×10^{-6}	0.13	0.00013
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00014
	Composite	7.6×10^{-6}	0.13	0.00014
Transport to Los Alamos National Laboratory	Traffic Fatality	N/A	0.00017 [e]	N/A
	Radioactive Release	N/A	8.6×10^{-8}	N/A
Salt Distill at Los Alamos National Laboratory	Earthquake	6.8×10^{-6}	0.090	0.00012
	Composite	6.9×10^{-6}	0.090	0.00012
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	4.6×10^{-6}	0.081	0.000084
	Composite	4.7×10^{-6}	0.083	0.000084
Transport to Savannah River Site	Traffic Fatality	N/A	0.00071 [e]	N/A
	Radioactive Release	N/A	4.9×10^{-8}	N/A
Purex at Savannah River Site	Earthquake (H-Canyon)	2.0×10^{-8}	0.00087	0.000010
	Composite	3.0×10^{-8}	0.0014	0.000011
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.000015**	**0.13**	**0.00013**
	Composite (Bldg. 707)	**0.000015**	**0.13**	**0.00013**
Other Electrorefining and Molten Salt Extraction Salt Residues				
Alternative 1 (No Action)				
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.000018	0.32	0.00033
	Composite	0.000019	0.32	0.00033
Alternative 2 (without Plutonium Separation)				
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.000018	0.32	0.00033
	Composite (Bldg. 707)	0.000019	0.32	0.00033
	Earthquake (Bldg. 371) [b]	9.8×10^{-7}	0.012	0.000012
	Composite (Bldg. 371) [b]	1.4×10^{-6}	0.016	0.000014

	Accident Scenario	Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)	Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)
Alternative 3 (with Plutonium Separation)				
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707)	0.000018	0.32	0.00033
	Composite	0.000019	0.32	0.00033
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	9.85×10^{-7}	0.011	0.000012
	Composite (Bldg. 371) [c]	1.4×10^{-6}	0.016	0.000014
	Earthquake (Bldg. 707A) [d]	0.000016	0.30	0.00031
	Composite (Bldg. 707A) [d]	0.000016	0.30	0.00031
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.000018	0.32	0.00033
	Composite	0.000019	0.32	0.00033
Transport to Los Alamos National Laboratory	Traffic Fatality	N/A	0.00125 [e]	N/A
	Radioactive Release	N/A	2.1×10^{-7}	N/A
Salt Distill at Los Alamos National Laboratory	Earthquake	0.000016	0.022	0.00028
	Composite	0.000017	0.022	0.00029
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.000011	0.19	0.00020
	Composite	0.000011	0.20	0.00020
Transport to Savannah River Site	Traffic Fatality	N/A	0.00018[c]	N/A
	Radioactive Release	N/A	1.9×10^{-7}	N/A
Purex at Savannah River Site	Earthquake (H-Canyon)	4.8×10^{-8}	0.0021	0.000025
	Composite	7.4×10^{-8}	0.0035	0.000026
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.000018**	**0.32**	**0.00033**
	Composite	**0.000019**	**0.32**	**0.00033**
IDC 365, 413 and 427 Salt Residues				
Alternative 1 (No Action)				
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	4.4×10^{-6}	0.047	0.000049
	Composite	4.5×10^{-6}	0.048	0.000049
Alternative 2 (without Plutonium Separation)				
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	4.4×10^{-6}	0.077	0.000079
	Composite (Bldg. 707)	4.5×10^{-6}	0.078	0.000080
	Earthquake (Bldg. 371) [b]	2.4×10^{-7}	0.0028	2.9×10^{-6}
	Composite (Bldg. 371) [b]	3.4×10^{-7}	0.0039	3.4×10^{-6}
Alternative 3 (with Plutonium Separation)				
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	2.4×10^{-7}	0.0028	2.9×10^{-6}
	Composite (Bldg. 371) [c]	3.5×10^{-7}	0.0041	3.5×10^{-6}
	Earthquake (Bldg. 707A) [d]	4.0×10^{-6}	0.074	0.000077
	Composite (Bldg. 707A) [d]	4.0×10^{-6}	0.075	0.000078
Pyro-Oxidize at Rocky Flats	**Earthquake (Bldg. 707)**	**4.4×10^{-6}**	**0.077**	**0.000080**
	Composite	**4.5×10^{-6}**	**0.079**	**0.000080**
Transport to Los Alamos National Laboratory	**Traffic Fatality**	**N/A**	**0.00009 [e]**	**N/A**
	Radioactive Release	**N/A**	**5.0×10^{-8}**	**N/A**

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Acid Dissolve at Los Alamos National Laboratory	**Earthquake** **Composite**	**2.0×10^{-6}** **2.0×10^{-6}**	**0.0026** **0.0026**	**0.000034** **0.000034**
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707) Composite	4.4×10^{-6} 4.5×10^{-6}	0.077 0.079	0.000080 0.000080
Transport to Los Alamos National Laboratory	Traffic Fatality Radioactive Release	N/A N/A	0.00009 [e] 5.0×10^{-8}	N/A N/A
Water Leach at Los Alamos National Laboratory	Earthquake Composite	3.0×10^{-6} 3.1×10^{-6}	0.0040 0.0040	0.000052 0.000052
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707) Composite	2.7×10^{-6} 2.7×10^{-6}	0.047 0.048	0.000048 0.000049
Transport to Savannah River Site	Traffic Fatality Radioactive Release	N/A N/A	0.0003 [e] 2.9×10^{-8}	N/A N/A
Purex at Savannah River Site	Earthquake (H-Canyon) Composite	1.1×10^{-8} 1.8×10^{-8}	0.00051 0.00083	6.1×10^{-6} 6.1×10^{-6}
Alternative 4 (Combination) **Repackage at Rocky Flats**	**Earthquake (Bldg. 707)** **Composite (Bldg. 707)**	**9.0×10^{-6}** **9.1×10^{-6}**	**0.079** **0.080**	**0.000081** **0.000081**
Other Direct Oxide Reduction Salt Residues				
Alternative 1 (No Action) Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707) Composite	1.6×10^{-6} 1.7×10^{-6}	0.028 0.029	0.000029 0.000030
Alternative 2 (without Plutonium Separation) Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707) Composite (Bldg. 707) Earthquake (Bldg. 371) [b] Composite (Bldg. 371) [b]	1.6×10^{-6} 1.7×10^{-6} 8.6×10^{-8} 1.2×10^{-7}	0.029 0.029 0.0010 0.0015	0.000029 0.000030 1.1×10^{-6} 1.3×10^{-6}
Alternative 3 (with Plutonium Separation) Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c] Composite (Bldg. 371) [c] Earthquake (Bldg. 707A) [d] Composite (Bldg. 707A) [d]	8.7×10^{-8} 1.3×10^{-7} 1.4×10^{-6} 1.5×10^{-6}	0.0010 0.0015 0.026 0.027	1.0×10^{-6} 1.3×10^{-6} 0.000028 0.000028
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707) Composite	1.6×10^{-6} 1.6×10^{-6}	0.028 0.029	0.000029 0.000029
Transport to Los Alamos National Laboratory	Traffic Fatality Radioactive Release	N/A N/A	0.00028 [e] 1.9×10^{-8}	N/A N/A
Acid Dissolve at Los Alamos National Laboratory	Earthquake Composite	7.4×10^{-7} 7.5×10^{-7}	0.00097 0.00098	0.000013 0.000013
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707) Composite	1.6×10^{-6} 1.6×10^{-6}	0.028 0.029	0.000029 0.000029
Transport to Los Alamos National Laboratory	Traffic Fatality Radioactive Release	N/A N/A	0.00028 [d] 1.9×10^{-8}	N/A N/A

	Accident Scenario	Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)	Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)
Water Leach at Los Alamos National Laboratory	Earthquake Composite	1.1×10^{-6} 1.1×10^{-6}	0.0015 0.0015	0.000020 0.000020
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707) Composite	9.8×10^{-7} 9.9×10^{-7}	0.017 0.017	0.000018 0.000018
Transport to Savannah River Site	Traffic Fatality Radioactive Release	N/A N/A	0.0001 [d] 1.1×10^{-8}	N/A N/A
Purex at Savannah River Site	Earthquake (H-Canyon) Composite	4.4×10^{-9} 6.9×10^{-9}	0.00020 0.00032	2.4×10^{-6} 2.4×10^{-6}
Alternative 4 (Combination) **Repackage at Rocky Flats**	**Earthquake (Bldg. 707)** **Composite**	**1.6×10^{-6}** **1.7×10^{-6}**	**0.028** **0.029**	**1.1×10^{-6}** **1.3×10^{-6}**

N/A = not applicable
[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Building 371 is designated as an alternate location for the Pyro-Oxidize and Blend Down process at Rocky Flats.
[c] Water Leach process in Building 371.
[d] Final calcination process in Building 707A.
[e] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.
Note: The risks due to the preferred processing technology are presented in bold type.

- **Other Electrorefining and Molten Salt Extraction Salt Residues—**The highest consequence to the public maximally exposed individual would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 371 occurs during residue processing prior to final calcination. The highest consequence to the public population would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707A occurs during the final calcination process. The highest consequence to the individual noninvolved onsite worker would occur if DOE decides to implement the salt distillation technolgoy at Los Alamos National Laboratory and an earthquake strong enough to collapse Building PF-4 at the TA-55 facility occurs during processing of the residue at Los Alamos National Laboratory.

  The highest risk to the public maximally exposed individual is estimated to be 0.000018 and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and store technology, an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and salt distill technology at Rocky Flats, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the salt distillation technology at Los Alamos National Laboratory, or an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The highest risk to the public population is estimated at 0.32 and would occur due to the same earthquake-initiated accidents as described for the maximally exposed individual. The highest risk to the noninvolved worker is estimated to be 0.00033 and would occur due to the same earthquake-initiated accidents described for the maximally exposed individual and the public population. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand.

- **IDC 365, 413, and 417 Salt Residues—**The highest consequence to all three receptors would occur if DOE decides to implement the repackage technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707 occurs.

  The highest risk to the public maximally exposed individual is estimated to be 9.0×10^{-6} and would occur due to an earthquake during repackaging of the residue in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand. The highest risk to the public population is estimated at 0.079 and would occur due to an earthquake during repackaging the residue in Rocky Flats Building 707. The highest risk to the noninvolved worker is estimated to be 0.000081 and would also occur due to an earthquake during repackaging of the residue at Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand.

- **Other Direct Oxide Reduction Salt Residues—**The highest consequence to the public maximally exposed individual would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 371 occurs during residue processing prior to final calcination. The highest consequences to the public population would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707A occurs during the final calcination process. The highest consequence to the noninvolved onsite worker would occur if DOE were to implement the water leach technology at Los Alamos National Laboratory and an earthquake occurs strong enough to collapse Building PF-4 of the TA-55 facility while processing the residue at Los Alamos.

  The highest risk to the public maximally exposed individual is estimated to be 1.6×10^{-6} and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize

technology under Alternative 1, an earthquake during processing the residue with the pyro-oxidize and blend down technology in Rocky Flats Building 707, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the acid dissolution technology at Los Alamos National Laboratory, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the water leach technology at Los Alamos National Laboratory, or an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a hundred thousand. The highest risk to the public population is estimated at 0.029 and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and blend down technology. The highest risk to the noninvolved onsite worker is estimated to be 0.000029 and would occur due to the same earthquake-initiated accidents described for the maximally exposed individual. The noninvolved worker's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand.

4.4 IMPACTS OF MANAGING COMBUSTIBLE RESIDUES

The inventory of combustible residues assessed in this EIS weighs 1,140 kg (2,513 lb), including 21.3 kg (47 lb) of plutonium. This inventory is stored in 69 drums with no internal metal containers.

As discussed in Chapter 2, the alternatives for combustible residues include one technology under the No Action Alternative, three technologies under the Process without Plutonium Separation Alternative, one technology under the Process with Plutonium Separation Alternative and one technology under Alternative 4. The first and last processing technologies are combinations of three different types of processes, one for each subcategory of combustible residues. The preferred processing technology is Alternative 4.

This section presents the environmental impacts of managing the entire inventory of combustible residues under each of the six technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Section 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.4.1 Products and Wastes

Every processing technology for combustible residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at Rocky Flats. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues, containing plutonium in excess of the safeguards termination limits. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone would not be generated from combustible residues because none of the technologies involve shipping the residues to the Savannah River Site for plutonium separation. If plutonium is separated at Rocky Flats, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. This separated plutonium would also contain the americium from the combustible residues.

The solid plutonium-bearing products and wastes that would be generated from combustible residues under each of the technologies are presented in **Table 4–16**. The shaded areas of Table 4–16 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (1,275 drums) would be generated in the catalytic chemical oxidation technology, but the mediated

Table 4–16 Products and Wastes from Combustible Residues

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
Alternative 1 (No Action) Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats	916	92			229	
Alternative 2 (without Plutonium Separation) Sonic Wash at Rocky Flats		423			229	
Catalytic Chemical Oxidation at Rocky Flats		1,275			2,727	
Blend Down at Rocky Flats		220			229	
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats		1,219		21	2,727	
Alternative 4 (Combination) **Neutralize & Dry/Desorb & Passivate/Repackage at Rocky Flats**	**916**[d]	**92**			**229**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each container is 2 feet (61 cm) in diameter, 10 feet (330 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technologies are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

electrochemical oxidation technology would generate almost as much (1,219 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than 423 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate over 1,000 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from combustible residues is 21 kg (46 lb).

4.4.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of combustible residues. These impacts are presented for incident-free operation and postulated accident scenarios, respectively. The detailed site analyses are presented in Appendix D. No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.4.2.1 Incident-Free Operations

- **Radiological Impacts—**The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–17**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of combustible residues. The length of time necessary to process the combustible residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing.

  The highest estimated public maximally exposed individual dose in Table 4–17 is 7.4×10^{-6} mrem, which would occur during the mediated electrochemical oxidation process at Rocky Flats. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one-hundred billion. The highest public population radiation dose listed in Table 4–17 would also occur for the mediated electrochemical oxidation process, if DOE decides to implement this technology. This dose is estimated to be 0.00016 person-rem, which would cause far less than one additional latent fatal cancer among the population living near Rocky Flats.

  The highest involved worker population radiation dose would be 42 person-rem, which would occur if DOE decides to implement the catalytic chemical oxidation technology. This dose would cause 0.017 additional latent fatal cancers among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

Table 4–17 Radiological Impacts Due to Incident-Free Management of Combustible Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem per year)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Alternative 1 (No Action)								
Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats	3.6×10^{-6}	1.8×10^{-12}	0.000081	4.1×10^{-8}	2,000	0.0008	32	0.013
Alternative 2 (without Plutonium Separation)								
Sonic Wash at Rocky Flats	7.0×10^{-6}	3.5×10^{-12}	0.00015	7.5×10^{-8}	2,000	0.0008	17	0.0068
Catalytic Chemical Oxidation at Rocky Flats	4.5×10^{-6}	2.3×10^{-12}	0.000096	4.8×10^{-8}	2,000	0.0008	42	0.017
Blend Down at Rocky Flats	3.0×10^{-6}	1.5×10^{-12}	0.000064	3.2×10^{-8}	2,000	0.0008	6.8	0.0027
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	7.4×10^{-6}	3.7×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	11	0.0044
Alternative 4 (Combination)								
Neutralize & Dry/Desorb & Passivate/Repackage at Rocky Flats	**3.6×10^{-6}**	**1.8×10^{-12}**	**0.000081**	**4.1×10^{-8}**	**2,000**	**0.0008**	**20**	**0.0080**

Note: The impacts due to the preferred processing technology are presented in bold type.

- **Hazardous Chemical Impacts—**The processing and storage of combustible residues at Rocky Flats involves potential releases of carcinogenic and noncarcinogenic chemicals. Under Alternative 1, the thermal desorption processing of organic contaminated combustible residues would release the carcinogen carbon tetrachloride. The probability of excess latent cancer incidence to the public maximally exposed individual as a result of exposure to carbon tetrachloride would be 6×10^{-11} (**Table 4–18**). The impacts due to the preferred processing technology are presented in bold type. This hypothetical individual's latent cancer incidence risk would be increased by less than one in ten billion. Carbon tetrachloride is no longer used at Rocky Flats, but is present in small amounts in some of the residues. Carbon tetrachloride produces central nervous system, pulmonary system, gastrointestinal system, and other systemic toxic effects in humans (Sax and Lewis 1987). The compound is an eye and skin irritant and damages the liver, kidneys, and lungs (Lewis 1991). The liver is the primary target organ for carbon tetrachloride toxicity (EPA 1991a). Less than one excess latent cancer incidence is estimated to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The maximally exposed individual worker probability of excess latent cancer incidence is 3×10^{-9}. If all site workers were exposed to the maximally exposed individual concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than 1 excess latent cancer would be expected to occur in the workforce population.

  The catalytic chemical oxidation process at Rocky Flats would involve the release of hydrochloric acid. Hydrochloric acid is toxic following ingestion and inhalation exposure. The compound is a strong eye, skin, and mucous membrane irritant (Lewis 1991). The estimated Hazard Index values presented in Table 4–18 are much less than one for both the offsite population maximally exposed individual and the noninvolved worker maximally exposed individual, which suggests that noncancer health effects are not expected.

4.4.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with combustible residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–19**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

Table 4–18 Chemical Impacts Due to Incident-Free Management of Combustible Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences***	***Probability of Cancer Incidence***	***Hazard Index***	***Number of Cancer Incidences***
Alternative 1 (No Action)						
Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats [a]	6×10^{-11}	N/E	<1 [b]	3×10^{-9}	N/E	<1 [c]
Alternative 2 (without Plutonium Separation)						
Sonic Wash at Rocky Flats [a]	1×10^{-11}	N/E	<1 [b]	7×10^{-10}	N/E	<1 [c]
Catalytic Chemical Oxidation at Rocky Flats [d]	N/E	5×10^{-11}	N/E	N/E	5×10^{-9}	N/E
Blend Down at Rocky Flats [e]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats [e]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 4 (Combination)						
Neutralize & Dry/Desorb & Passivate/Repackage at Rocky Flats	**6×10^{-11}**	**N/E**	**< 1 [b]**	**3×10^{-9}**	**N/E**	**< 1 [c]**

N/E = no emissions

[a] Only carcinogenic chemicals are released from the process; therefore, only cancer health risks are evaluated.

[b] In population of 2.4 million individuals living within 80 km (50 mi) of Rocky Flats.

[c] Based on the extremely conservative assumption that entire Rocky Flats workforce is exposed to the maximally exposed individual concentration.

[d] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

[e] No hazardous chemicals are released from process; therefore, no associated health risks exist. See Section 4.12 for additional information.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–19 Accident Frequencies, Process Durations, and Consequences for Accidents with Combustible Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Alternative 1 (No Action)									
Neutralize, Dry, and Store at Rocky Flats [a] (Aqueous Contaminated Residue)	Dock Fire (Bldg. 371) [b]	2.0×10^{-6}	0.15	1,800	0.00090	21,000	11	14,000	0.0056
	Room Fire (Bldg. 371) [c]	0.0005	0.15	219	0.00011	2,560	1.3	1,710	0.00068
Thermally Desorb, Steam Passivate, and Store at Rocky Flats (Organic Contaminated Residue)	Dock Fire (Bldg. 371) [b]	2.0×10^{-6}	0.39	1,800	0.00090	21,000	11	14,000	0.0056
	Room Fire (Bldg. 371) [c]	0.0005	0.39	59	0.000029	683	0.34	455	0.00018
Repackage and Store at Rocky Flats (Dry Contaminated Residue)	Dock Fire (Bldg. 707) [b]	2.0×10^{-6}	0.023	1,200	0.00060	21,000	11	14,000	0.0056
	Earthquake (Bldg. 707) [c]	0.0026	0.023	312	0.00016	5,460	2.7	3,640	0.0015
Alternative 2 (without Plutonium Separation)									
Sonic Wash at Rocky Flats	Dock Fire (Bldg. 371) [b]	2.0×10^{-6}	0.31	1,800	0.00090	21,000	11	14,000	0.0056
	Room Fire (Bldg. 371) [c]	0.0005	0.31	151	0.000076	1,760	0.88	1,170	0.00047
Catalytic Chemical Oxidation at Rocky Flats	Dock Fire (Bldg. 371) [b]	2.0×10^{-6}	1.03	1,800	0.00090	21,000	11	14,000	0.0056
	Room Fire (Bldg. 371) [c]	0.0005	1.03	110	0.000055	1,280	0.64	854	0.00034
Blend Down at Rocky Flats	Dock Fire (Bldg. 371) [b]	2.0×10^{-6}	0.059	1,800	0.00090	21,000	11	14,000	0.0056
	Room Fire (Bldg. 371) [c]	0.0005	0.059	1,260	0.00063	14,700	7.4	9,820	0.0039
	Dock Fire (Bldg. 707) [b, d]	2×10^{-6}	0.059	1,200	0.00060	21,000	11	14,000	0.0056
	Earthquake (Bldg. 707) [c, d]	0.0026	0.059	492	0.00025	8,600	4.3	5,730	0.0023
Alternative 3 (with Plutonium Separation)									
Mediated Electrochemical Oxidation at Rocky Flats	Dock Fire (Bldg. 371) [b, e]	2.0×10^{-6}	0.16	1,800	0.00090	21,000	11	14,000	0.0056
	Room Fire (Bldg. 371) [c, e]	0.0005	0.16	473	0.00024	5,510	2.8	3,680	0.0015
	Dock Fire (Bldg. 707A) [b, f]	2.0×10^{-6}	0.13	1,200	0.00060	25,000	13	21,000	0.017
	Earthquake (Bldg. 707A) [b, f]	0.0026	0.13	105	0.000053	2,190	1.1	1,840	0.0074
Alternative 4 (Combination)									
Neutralize and Dry at Rocky Flats (Aqueous Contaminated Residue)	**Dock Fire (Bldg. 371) [b]**	**2.0×10^{-6}**	**0.15**	**1,800**	**0.00090**	**21,000**	**11**	**14,000**	**0.0056**
	Room Fire (Bldg. 371) [c]	**0.0005**	**0.15**	**219**	**0.00011**	**2,560**	**1.3**	**1,710**	**0.00068**
Thermally Desorb and Steam Passivate at Rocky Flats (Organic Contaminated Residue)	**Dock Fire (Bldg. 371) [b]**	**2.0×10^{-6}**	**0.39**	**1,800**	**0.00090**	**21,000**	**11**	**14,000**	**0.0056**
	Room Fire (Bldg. 371) [c]	**0.0005**	**0.39**	**59**	**0.000029**	**683**	**0.34**	**455**	**0.00018**
Repackage at Rocky Flats (Dry Contaminated Residue)	**Dock Fire (Bldg. 707) [b]**	**2.0×10^{-6}**	**0.023**	**1,200**	**0.00060**	**21,000**	**11**	**14,000**	**0.0056**
	Earthquake (Bldg. 707) [c]	**0.0026**	**0.023**	**312**	**0.00016**	**5,460**	**2.7**	**3,624**	**0.0015**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Highest consequence accident for this processing technology.
[c] Highest risk accident for this processing technology.
[d] Mediated electrochemical oxidation process in Building 371.
[e] Building 707 is designated as an alternate location for the Shred and Blend Down process at Rocky Flats.
[f] Final calcination process in Building 707A.
Note: The impacts due to the preferred processing technology are presented in bold type.

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–19 for each of the six combustible residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequence to the maximally exposed individual would occur if DOE decides to implement either the neutralize and dry, the thermal desorption and steam passivation, the sonic wash, the catalytic chemical oxidation, the blend down, or the mediated electrochemical oxidation technology at Rocky Flats and a fire occurs on the loading dock of Building 371. The highest consequence to the public population and the noninvolved onsite worker would occur if DOE decides to implement the mediated electrochemical oxidation process at Rocky Flats and a dock fire occurs in Building 707A during the final calcination.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–20** for each of the six combustible residue processing technologies. (The No Action and Combination processing options are actually combinations of three processing technologies, one for each kind of combustible residue.) The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 3.8×10^{-8}, which is due to an earthquake during processing of the residue with the blend down technology at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten million. The highest risk to the public population is estimated to be 0.00066 latent cancer fatalities, which is also due to an earthquake during processing of the residue with the blend down technology. The highest risk to the individual noninvolved onsite worker is estimated to be 3.5×10^{-7}, which is due to the same accident scenario in the same technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million.

4.5 IMPACTS OF MANAGING PLUTONIUM FLUORIDE RESIDUES

The inventory of plutonium fluoride residues assessed in this EIS weighs 315 kg (694 lb), including 142 kg (313 lb) of plutonium. This inventory is stored in 256 small individual containers.

As discussed in Chapter 2, the alternatives for plutonium fluoride residues include one technology under the No Action Alternative, one technology under Process without Plutonium Separation Alternative, and two technologies under the Process with Plutonium Separation Alternative. There is no processing technology under Alternative 4. The preferred processing technology is to repackage the residues at Rocky Flats and to use Purex at the Savannah River Site.

This section presents the environmental impacts of managing the entire inventory of plutonium fluoride residues under each of the four technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

Table 4–20 Risks Due to Accidents with Combustible Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Neutralize, Dry, and Store at Rocky Flats [a]	Room Fire (Bldg. 371)	8.2×10^{-9}	0.000096	5.1×10^{-8}
(Aqueous Contaminated Residue)	Composite	9.4×10^{-9}	0.00011	5.9×10^{-8}
Thermally Desorb, Steam Passivate, and Store at	Room Fire (Bldg. 371)	5.7×10^{-9}	0.000067	3.5×10^{-8}
Rocky Flats (Organic Contaminated Residue)	Composite	7.0×10^{-9}	0.000082	4.4×10^{-8}
Repackage and Store at Rocky Flats	Earthquake (Bldg. 707)	9.3×10^{-9}	0.00016	8.7×10^{-8}
(Dry Contaminated Residue)	Composite	1.3×10^{-8}	0.00022	1.2×10^{-7}
Alternative 2 (without Plutonium Separation)				
Sonic Wash at Rocky Flats	Room Fire (Bldg. 371)	1.2×10^{-8}	0.00014	7.3×10^{-8}
	Composite	1.4×10^{-8}	0.00016	8.4×10^{-8}
Catalytic Chemical Oxidation at Rocky Flats	Room Fire (Bldg. 371)	2.8×10^{-8}	0.00033	1.8×10^{-7}
	Composite	7.4×10^{-8}	0.00039	2.2×10^{-7}
Blend Down at Rocky Flats	Room Fire (Bldg. 371)	1.9×10^{-8}	0.00022	1.2×10^{-7}
	Composite (Bldg. 371)	2.1×10^{-8}	0.00024	1.3×10^{-7}
	Earthquake (Bldg. 707) [b]	3.8×10^{-8}	0.00066	3.5×10^{-7}
	Composite (Bldg. 707) [b]	5.1×10^{-8}	0.00088	4.7×10^{-7}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Room Fire (Bldg. 371) [c]	1.9×10^{-8}	0.00022	1.2×10^{-7}
	Composite	2.8×10^{-8}	0.00030	1.3×10^{-7}
	Earthquake (Bldg. 707A) [d]	1.8×10^{-8}	0.00037	2.5×10^{-8}
	Composite	2.5×10^{-8}	0.00053	3.6×10^{-7}
Alternative 4 (Combination)				
Neutralize and Dry at Rocky Flats	**Room Fire (Bldg. 371)**	**8.2×10^{-9}**	**0.000096**	**5.1×10^{-8}**
(Aqueous Contaminated Residue)	**Composite**	**9.4×10^{-9}**	**0.00011**	**5.9×10^{-8}**
Thermally Desorb and Steam Passivate at Rocky Flats	**Room Fire (Bldg. 371)**	**5.7×10^{-9}**	**0.000067**	**3.5×10^{-8}**
(Organic Contaminated Residue)	**Composite**	**7.0×10^{-9}**	**0.000082**	**4.4×10^{-8}**
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**9.3×10^{-9}**	**0.00016**	**8.7×10^{-8}**
(Dry Contaminated Residue)	**Composite**	**1.3×10^{-9}**	**0.00022**	**1.2×10^{-8}**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 707 is designated as an alternate location for the Shred and Blend Down process at Rocky Flats.

[c] Mediated electrochemical oxidation process in Building 371.

[d] Final calcination process in Building 707A.

Note: The risks due to the preferred processing technology are presented in bold type.

4.5.1 Products and Wastes

Every processing technology for plutonium fluoride residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures.

The No Action Alternative would generate stabilized residues that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2.

High-level waste and saltstone would be generated only at the Savannah River Site if the residues are shipped to that site for plutonium separation. The final form for the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a by-product of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults.

If plutonium is separated at Rocky Flats or the Savannah River Site, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. Any plutonium separated at Rocky Flats would contain americium, while at the Savannah River Site the americium would go into the high-level waste.

The solid plutonium-bearing products and wastes that would be generated from plutonium fluoride residues under each of the technologies are presented in **Table 4–21**. The shaded areas of Table 4–21 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (3,923 drums) would be generated in the blend down technology. This amount is much higher than the other technologies, which would generate no more than 333 drums of transuranic waste.

The quantities of high-level waste, low-level waste, and saltstone would be very low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated is 141 kg (310 lb).

4.5.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the alternatives associated with the management of plutonium fluoride residues. These impacts are presented for incident-free operation and postulated accident scenarios, respectively. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship the plutonium fluoride residues to the Savannah River Site for Purex processing, then seven shipments would be required and the total round-trip shipping distance would be 36,600 km (22,700 mi).

Table 4–21 Products and Wastes from Plutonium Fluoride Residues

	Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*High-Level Waste (Canisters of Glass)* [b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)* [a]	*Saltstone (cubic meters)*
Alternative 1 (No Action) Dissolve, Oxidize, and Store at Rocky Flats	141	333			750	
Alternative 2 (without Plutonium Separation) Blend Down at Rocky Flats		3,923			60	
Alternative 3 (with Plutonium Separation) Acid Dissolve at Rocky Flats		333		141	750	
Preprocess at Rocky Flats		**28**	**–**	**–**	**60**	**–**
Purex at the Savannah River Site		**12**	**0.2**	**141**	**45**	**18**

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)

[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.

[c] To convert to pounds, multiply by 2.2.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technology are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.5.2.1 Incident-Free Operations

- **Radiological Impacts—**The radiological impacts to the public and the workers associated with incident-free operations of each technlogy are presented in **Table 4–22**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of plutonium fluoride residues. The length of time necessary to process the plutonium fluoride residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–22 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–22 would occur if DOE decides to implement the option to perform Purex processing at the Savannah River Site. The sum of these doses is 0.71 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  For these residues, the workers would be exposed to neutron radiation from the alpha-neutron reaction between plutonium and fluorine in addition to the normal radiations from plutonium and americium. As explained in DOE's Response to Comment Number 10 in Chapter 9, this neutron radiation is included in the dose estimates in this section. The highest involved worker population radiation dose would be 356 person-rem, which would occur if DOE decides to implement the option to blend down at Rocky Flats. This dose would cause 0.14 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- **Hazardous Chemical Impacts—**The processing of plutonium fluoride residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

  No carcinogenic chemicals would be released from the Purex process at the Savannah River Site. Noncancer health risks resulting from releases of phosphoric acid and ammonium nitrate are low; the Hazard Index values presented in **Table 4–23** are much less than one. Phosphoric acid, the constituent of the process source term that accounts for the largest increment of noncancer risk, is a corrosive irritant to the eyes, skin and mucous membranes and a respiratory tract irritant following inhalation exposure (Lewis 1991, EPA 1995a). The impacts due to the preferred processing technlogy are presented in bold type.

Table 4–22 Radiological Impacts Due to Incident-Free Management of Plutonium Fluoride Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem per year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Alternative 1 (No Action)								
Dissolve, Oxidize, and Store at Rocky Flats	0.000043	2.2×10^{-11}	0.00098	4.9×10^{-7}	2,000	0.0008	47	0.019
Alternative 2 (without Plutonium Separation)								
Blend Down at Rocky Flats	N/E	–	N/E	–	2,000	0.0008	356	0.142
Alternative 3 (with Plutonium Separation)								
Acid Dissolve at Rocky Flats	0.000043	2.2×10^{-11}	0.00098	4.9×10^{-7}	2,000	0.0008	45	0.018
Preprocess at Rocky Flats	**9.9×10^{-6}**	**5.0×10^{-12}**	**0.00021**	**1.1×10^{-7}**	**2,000**	**0.0008**	**41**	**0.016**
Transport to Savannah River Site	**11**	**5.5×10^{-6}**	**0.69**	**0.00035**	**100**	**0.00004**	**1.1**	**0.00044**
Purex at Savannah River Site [a]	**0.00020**	**1×10^{-10}**	**0.022**	**0.000011**	**2,000**	**0.0008**	**34**	**0.013**

N/E = no emissions—therefore, there are no radiological impacts to the public

[a] Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–23 Chemical Impacts Due to Incident-Free Management of Plutonium Fluoride Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities [a]*	*Probability of Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities [a]*
Alternative 1 (No Action)						
Dissolve, Oxidize, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Acid Dissolve at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Preprocess at Rocky Flats [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Transport to Savannah River Site	**N/A**	**N/A**	**0.00009 [c]**	**N/A**	**N/A**	**(c)**
Purex at Savannah River Site [d, e]	**N/E**	**1×10^{-9}**	**N/E**	**N/E**	**2×10^{-8}**	**N/E**

N/E = no emissions N/A = not applicable—the maximally exposed individual is undefined for vehicle emissions

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from this process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates. See Appendix E, Section E.4 for additional details.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The impacts due to the preferred processing technology are presented in bold type.

4.5.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with plutonium fluoride residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technlogies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–24**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–24, for each of the four plutonium fluoride residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs

The highest consequences to all three receptors would occur if DOE decides to implement the preferred processing technology and a major earthquake strong enough to cause the breach of Building 371 occurs during the 0.17 years of preprocessing the residue at Rocky Flats.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–25**, for each of the four plutonium fluoride residue processing technologies. The risk associated with the highest risk accident and a composite risk due to all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

Table 4–24 Accident Frequencies, Process Durations, and Consequences for Accidents with Plutonium Fluoride Residues

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer or Traffic Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Alternative 1 (No Action)									
Dissolve, Oxidize, and Store at Rocky Flats [a]	Earthquake (Bldg. 371) [b]	0.000094	0.49	1,600	0.00080	18,600	9.3	12,400	0.0050
	Earthquake (Bldg 707A) [c]	0.0026	0.34	760	0.00038	15,800	7.9	13,300	0.0053
Alternative 2 (without Plutonium Separation)									
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.57	330	0.00017	5,780	2.9	3,850	0.0015
	Earthquake (Bldg. 371) [d]	0.000094	1.57	496	0.00025	5,780	2.9	3,850	0.0015
Alternative 3 (with Plutonium Separation)									
Acid Dissolve at Rocky Flats	Earthquake (Bldg. 371) [b]	0.000094	0.49	1,600	0.00080	18,600	9.3	12,400	0.0050
	Earthquake (Bldg 707A) [c]	0.0026	0.34	760	0.00038	15,800	7.9	13,300	0.0053
Preprocess at Rocky Flats	**Earthquake (Bldg. 371)**	**0.000094**	**0.17**	**4,490**	**0.0023**	**52,400**	**26**	**34,900**	**0.028**
Transport to Savannah River Site	**Traffic Fatality**	**0.00010 per shipment**	**7 shipments**	**N/A**	**N/A**	**N/A**	**1.0 [e]**	**N/A**	**N/A [f]**
Purex at Savannah River Site	**Earthquake (H- Canyon) [g]**	**0.000182**	**1.58**	**74**	**0.000037**	**3,330**	**1.7**	**23,600**	**0.019**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Acid dissolution process in Building 371.

[c] Final calcination process in Building 707A.

[d] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[e] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list in a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[f] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

[g] HB-Line operates 12.5 percent of the time. Dose estimates assumed the HB-Line was operating at the time of the accident.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–25 Risks Due to Accidents with Plutonium Fluoride Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Dissolve, Oxidize, and Store at Rocky Flats [a]	Earthquake (Bldg. 371) [b]	3.7×10^{-8}	0.00043	2.3×10^{-7}
	Composite	5.9×10^{-8}	0.00063	2.5×10^{-7}
	Earthquake (Bldg. 707A) [c]	3.4×10^{-7}	0.0070	4.7×10^{-6}
	Composite	3.4×10^{-7}	0.0070	4.7×10^{-6}
Alternative 2 (without Plutonium Separation)				
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	6.7×10^{-7}	0.012	6.3×10^{-6}
	Composite (Bldg. 707)	6.8×10^{-7}	0.012	6.4×10^{-6}
	Earthquake (Bldg. 371) [d]	3.7×10^{-8}	0.00043	2.3×10^{-7}
	Composite (Bldg. 371) [d]	4.5×10^{-8}	0.00053	2.8×10^{-7}
Alternative 3 (with Plutonium Separation)				
Acid Dissolve at Rocky Flats	Earthquake (Bldg. 371) [b]	3.7×10^{-8}	0.00043	2.3×10^{-7}
	Composite	5.9×10^{-8}	0.00063	2.5×10^{-7}
	Earthquake (Bldg. 707A) [c]	3.4×10^{-7}	0.0070	4.7×10^{-6}
	Composite	3.4×10^{-7}	0.0070	4.7×10^{-6}
Preprocess at Rocky Flats	**Earthquake (Bldg. 371)**	**3.6×10^{-8}**	**0.00042**	**4.5×10^{-7}**
	Composite	**3.7×10^{-8}**	**0.00043**	**4.5×10^{-7}**
Transport to Savannah River Site	**Traffic Fatality**	**N/A**	**0.0007 [d]**	**N/A**
	Radioactive Release	**N/A**	**3.1×10^{-6}**	**N/A**
Purex at Savannah River Site	**Earthquake (H-Canyon) [f]**	**3.5×10^{-9}**	**0.00016**	**1.8×10^{-6}**
	Composite [e]	**6.6×10^{-9}**	**0.00030**	**1.8×10^{-6}**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[a] Acid dissolution process in Building 371.

[b] Final calcination process in Building 707A.

[c] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[d] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

[e] The H-Canyon operates 100 percent of the time and the HB-Line operates 12.5 percent of the time.

Note: The risks due to the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 6.7×10^{-7}, which is due to an earthquake during processing of the residue with the blend down technology in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.012 latent cancer fatalities, which is also due to an earthquake at Rocky Flats during processing of the residue with the blend down technology in Building 707. The highest risk to the individual noninvolved onsite worker is estimated to be 6.3×10^{-6}, which is due to the same accident scenario in the same technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

4.6 IMPACTS OF MANAGING FILTER MEDIA RESIDUES

The inventory of filter media residues assessed in this EIS weighs 2,624 kg (5,785 lb), including 112 kg (247 lb) of plutonium. This inventory is stored in 281 drums and 8 other small individual containers. As discussed in Chapter 2, the filter media residues are divided into three categories. These subcategories are listed in **Table 4–26**, along with the inventory data for each one.

Table 4–26 Filter Media Residues

Filter Media Subcategories	*Residue Mass (kg)*[a]	*Plutonium Mass (kg)*[a]	*Number of Drums*	*Number of Other Individual Containers*
IDC 331	800	19.6	74	1
IDC 338	1,700	90.4	195	6
Other Filter Media	124	2.0	12	1
Totals	2,624	112	281	8

[a] To convert to pounds, multiply by 2.2.

As discussed in Chapter 2, the processing technologies for the three subcategories of filter media residues are rather similar. All three have the same one technology under the No Action Alternative, two technologies under the Processing without Plutonium Separation Alternative, and one technology under the Processing with Plutonium Separation Alternative. The IDC 338 and Other High-Efficiency Particulate Air Filter Media include the technology of vitrification and they have one technology under Alternative 4. There is no processing technology for IDC 331 residues under Alternative 4. The preferred processing technologies for the IDC 331, IDC 338, and other filter media residues are blend down, neutralize/dry, and repackage at Rocky Flats, respectively.

This section presents the environmental impacts of managing the entire inventory of each subcategory of filter media residues under each of the technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.6.1 Products and Wastes

Every processing technology for filter media residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at the Rocky Flats. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter

(55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone will not be generated from filter media residues because none of the technologies involve shipping the residues to the Savannah River Site for plutonium separation. If plutonium is separated at Rocky Flats, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. This separated plutonium would also contain the americium from the filter media residues.

The solid plutonium-bearing products and wastes that would be generated from high-efficiency particulate air filter media residues under each of the technologies are presented in **Table 4–27**. The shaded areas of Table 4–27 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technologies are presented in bold type.

- **IDC 331 Ful Flo Filter Media Residues—**The largest amount of transuranic waste (860 drums) would be generated in the mediated electrochemical oxidation at Rocky Flats processing technology. The amount of waste from this process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. This technology would generate much more transuranic waste than the other technologies, which would generate fewer than 400 drums. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from the IDC 331 Ful Flo Filter Media Residues is 19 kg (42 lb).

- **IDC 338 High-Efficiency Particulate Air Filter Media Residues—**The largest amount of transuranic waste (1,827 drums) would be generated in the mediated electrochemical oxidation at Rocky Flats processing technology. The amount of waste from this process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. This technology would generate much more transuranic waste than the other technologies, which would generate fewer than 800 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate over 3,300 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from the IDC 338 High-Efficiency Particulate Air Media Residues is 88 kg (194 lb).

- **Other High-Efficiency Particulate Air Filter Media Residues—**The largest amount of transuranic waste (133 drums) would be generated in the mediated electrochemical oxidation at Rocky Flats processing technology. The amount of waste from this process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. This technology would generate much more transuranic waste than the other technologies, which would generate no more than about 50 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate almost 100 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from the Other High-Efficiency Particulate Air Media Residues is 2 kg (4 lb).

Table 4–27 Products and Wastes from Filter Media Residues

	Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*High-Level Waste (Canisters of Glass)* [b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)* [a]	*Saltstone (cubic meters)*
IDC 331 Ful Flo Filter Media						
Alternative 1 (No Action)						
Neutralize/Dry and Store at Rocky Flats	1,517	65			166	
Alternative 2 (without Plutonium Separation)						
Blend Down at Rocky Flats		**269**			**166**	
Sonic Wash at Rocky Flats		343			166	
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats		860		19	1,919	
IDC 338 High-Efficiency Particulate Air Filter Media						
Alternative 1 (No Action)						
Neutralize/Dry and Store at Rocky Flats	3,223	138			360	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		656			360	
Blend Down at Rocky Flats		572			360	
Sonic Wash at Rocky Flats		730			360	
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats		1,827		88	4,085	
Alternative 4 (Combination)						
Neutralize/Dry at Rocky Flats	**3,223**[d]	**138**			**360**	
Other High-Efficiency Particulate Air Filter Media						
Alternative 1 (No Action)						
Neutralize/Dry and Store at Rocky Flats	96	10			25	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		48			25	
Blend Down at Rocky Flats		42			25	
Sonic Wash at Rocky Flats		53			25	
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats		133		2	297	
Alternative 4 (Combination)						
Repackage at Rocky Flats	**87** [d]	**10**			**25**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The storage capacities at each site are adequate to store the products and wastes listed in this table.

The impacts due to the preferred processing technologies are presented in bold type.

4.6.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the alternatives associated with the management of filter media residues. These impacts are presented for incident-free operation and postulated accident scenarios, respectively. The detailed site analyses are presented in Appendix D.

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modification would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.6.2.1 Incident-Free Operations

- **Radiological Impacts—**The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–28**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of filter media residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing.

  - *IDC 331 Ful Flo Filter Media*—The highest estimated public maximally exposed individual dose from IDC 331 Ful Flo filter media operations is 5.7×10^{-6} mrem, which would occur during the sonic wash process at Rocky Flats. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred billion. The highest public population radiation dose from Ful Flo filter media operations would occur for both the sonic wash and mediated electrochemical oxidation processes, if DOE decides to implement either technology. The dose is estimated to be 0.00012 person-rem, which would cause far less than one additional latent fatal cancer among the population living near Rocky Flats.

    The highest involved worker population radiation dose for IDC 331 Ful Flo filter media operations would be 28 person-rem. This dose would occur if DOE decides to implement the neutralize/dry and store (No Action) technology and it would cause 0.011 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers". The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

  - *IDC 338 High-Efficiency Particulate Air Filter Media*—The highest estimated public maximally exposed individual dose from IDC 338 high-efficiency particulate air filter media operations is 0.000026 mrem, which would occur during the sonic wash process at Rocky Flats. This hypothetical individual's latent fatal cancer risk would be increased by less than one in ten-billion.

    The highest public population radiation dose from IDC 338 high-efficiency particulate air filter media operations would also occur for the sonic wash process, if DOE decides to implement this techology. This dose is estimated to be 0.00056 person-rem, which would cause far less than one additional latent fatal cancer among the population living near Rocky Flats.

Table 4–28 Radiological Impacts Due to Incident-Free Management of Filter Media Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem/yr)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
IDC 331 Ful Flo Filter Media								
Alternative 1 (No Action) Neutralize, Dry and Store at Rocky Flats	4.2×10^{-6}	2.1×10^{-12}	0.000088	4.4×10^{-8}	2,000	0.0008	28	0.011
Alternative 2 (without Plutonium Separation) **Blend Down at Rocky Flats**	**2.7×10^{-6}**	**1.4×10^{-12}**	**0.000057**	**2.9×10^{-8}**	**2,000**	**0.0008**	**5.5**	**0.0022**
Sonic Wash at Rocky Flats	5.7×10^{-6}	2.8×10^{-12}	0.00012	6.0×10^{-8}	2,000	0.0008	8.9	0.0036
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	5.5×10^{-6}	2.8×10^{-12}	0.00012	6.0×10^{-8}	2,000	0.0008	6.2	0.0025
IDC 338 High-Efficiency Particulate Air Filter Media								
Alternative 1 (No Action) Neutralize, Dry and Store at Rocky Flats	0.000019	9.5×10^{-12}	0.00041	2.0×10^{-7}	2,000	0.0008	82	0.033
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	4.1×10^{-6}	2.1×10^{-12}	0.00017	8.5×10^{-8}	2,000	0.0008	23	0.0092
Blend Down at Rocky Flats	0.000013	6.5×10^{-12}	0.00026	1.3×10^{-7}	2,000	0.0008	25	0.010
Sonic Wash at Rocky Flats	0.000026	1.3×10^{-11}	0.00056	2.8×10^{-7}	2,000	0.0008	39	0.016
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	0.000025	1.3×10^{-11}	0.00053	2.7×10^{-7}	2,000	0.0008	28	0.011
Alternative 4 (Combination) **Neutralize and Dry at Rocky Flats**	**0.000019**	**9.5×10^{-12}**	**0.00041**	**2.0×10^{-7}**	**2,000**	**0.0008**	**41**	**0.016**
Other High-Efficiency Particulate Air Filter Media								
Alternative 1 (No Action) Neutralize, Dry and Store at Rocky Flats	4.2×10^{-7}	2.1×10^{-13}	9.0×10^{-6}	4.5×10^{-9}	2,000	0.0008	2.1	0.00084
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	9.3×10^{-8}	4.7×10^{-14}	3.8×10^{-6}	1.9×10^{-9}	2,000	0.0008	0.51	0.00020
Blend Down at Rocky Flats	2.8×10^{-7}	1.4×10^{-13}	6.0×10^{-6}	3.0×10^{-9}	2,000	0.0008	1.7	0.00068
Sonic Wash at Rocky Flats	6.0×10^{-7}	3.0×10^{-13}	0.000013	6.5×10^{-9}	2,000	0.0008	0.88	0.00035
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	5.7×10^{-7}	2.9×10^{-13}	0.000012	6.0×10^{-9}	2,000	0.0008	0.64	0.00026
Alternative 4 (Combination) **Repackage at Rocky Flats**	**4.3×10^{-8}**	**2.2×10^{-14}**	**1.8×10^{-6}**	**9.0×10^{-10}**	**2,000**	**0.0008**	**1.6**	**0.00064**

Note: The impacts due to the preferred processing technology are presented in bold type.

The highest involved worker population radiation dose for IDC 338 high-efficiency particulate air filter media operations would be 82 person-rem. This dose would occur if DOE decides to implement the neutralize/dry and store (No Action) technology and it would cause 0.033 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Other High-Efficiency Particulate Air Filter Media*—The highest estimated public maximally exposed individual dose from other high-efficiency particulate air filter media operations is 6.0×10^{-7} mrem, which would occur during the sonic wash process at Rocky Flats. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one trillion.

  The highest public population radiation dose from other high-efficiency particulate air filter media operations would also occur for the sonic wash process, if DOE decides to implement this technology. The dose is estimated to be 0.000013 person-rem, which would cause far less than one additional latent fatal cancer among the population living near Rocky Flats.

  The highest involved worker population radiation dose for other high-efficiency particulate air filter media operations would be 2.1 person-rem. This dose would occur if DOE decides to implement the neutralize/dry and store (No Action) technology and it would cause 0.00084 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

❒ **Hazardous Chemical Impacts—**The processing of filter media residues at Rocky Flats would involve potential releases of the carcinogen carbon tetrachloride. Carbon tetrachloride is no longer used at Rocky Flats, but is present in small amounts in some of the residues. Under Alternative 2, the sonic wash processing has an estimated probability of excess latent cancer incidence for the offsite population maximally exposed individual of 7×10^{-12} for IDC 331 Ful Flo filter media, 3×10^{-11} for IDC 338 high-efficiency particulate air filter media, and 7×10^{-13} for other air filter media (**Table 4–29**). The impacts due to the preferred processing technologies are presented in bold type. This hypothetical individual's latent cancer chance would be increased by less than one in one billion. Less than one excess latent cancer incidence is estimated to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats for both types of media. The maximally exposed individual worker probability of excess latent cancer incidence would be 4×10^{-10} for IDC 331 Ful Flo filter media, 2×10^{-9} for IDC 338 high-efficiency particulate air filter media, and 4×10^{-11} for other air filter media. This hypothetical individual's chance of incurring a latent cancer would be increased by about one in one hundred million. If all site workers were exposed to the maximally exposed individual worker concentrations of carbon tetrachloride, less than 1 excess latent cancer would be expected to occur in the workforce population.

4.6.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with filter media residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for

comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other.

Table 4–29 Chemical Impacts Due to Incident-Free Management of Filter Media Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of a Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences*	*Probability of a Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences*
IDC 331 Ful Flo Filter Media						
Alternative 1 (No Action)						
Neutralize, Dry and Store at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Blend at Rocky Flats [a]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Sonic Wash at Rocky Flats	7×10^{-12}	N/E	<1 [c]	4×10^{-10}	N/E	<1 [d]
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
IDC 338 High-Efficiency Particulate Air Filter Media						
Alternative 1 (No Action)						
Neutralize, Dry and Store at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Blend Down at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Sonic Wash at Rocky Flats [b]	3×10^{-11}	N/E	<1 [c]	2×10^{-9}	N/E	<1 [d]
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 4 (Combination)						
Neutralize and Dry at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Other High-Efficiency Particulate Air Filter Media						
Alternative 1 (No Action)						
Neutralize, Dry and Store at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Blend Down at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Sonic Wash at Rocky Flats [b]	7×10^{-13}	N/E	<1 [c]	4×10^{-11}	N/E	<1 [d]
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats [a]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**

N/E = No emissions.

[a] No hazardous chemicals are released from process; therefore, no associated health risks exist.

[b] No noncarcinogenic hazardous chemicals are released from the process; therefore, only cancer health risks are evaluated.

[c] In population of 2.4 million individuals living within 80 km (50 mi) of Rocky Flats.

[d] Based on extremely conservative assumption that entire Rocky Flats workforce is exposed to the maximally exposed individual worker concentration.

Note: The impacts due to the preferred processing technology are presented in bold type.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–30**. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–30 for each of the filter media residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–31** for each of the five filter media residue processing technologies. The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented.

- **IDC 331 Ful Flo Filter Media** - The highest consequences to all three receptors would occur if DOE decides to implement the mediated electrochemical oxidation technology at Rocky Flats and a major earthquake occurs strong enough to collapse Building 371 during the processing of the residues prior to final calcination.

  The highest risk to the public maximally exposed individual is estimated to be 9.1×10^{-8} and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the blend down technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten million. The highest risk to the public population is estimated at 0.0016 and would also occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the blend down technology. The highest risk to the noninvolved worker is estimated to be 8.5×10^{-7} and would occur due to the same accident as for the maximally exposed individual and public population. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a million.

- **IDC 338 High-Efficiency Particulate Filter Media** - The highest consequences to all three receptors would occur if DOE decides to implement the mediated electrochemical oxidation technology at Rocky Flats and a major earthquake occurs strong enough to collapse Building 371 during the processing of the residues prior to final calcination.

  The highest risk to the public maximally exposed individual is estimated to be 4.3×10^{-7} and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the blend down technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a million. The highest risk to the public population is estimated at 0.0076 and would also occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the blend down technology. The highest risk to the noninvolved worker is estimated to be 4.0×10^{-6} and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the blend down technology or an earthquake during final calcination of the residue in Rocky Flats Building 707A for the

mediated electrochemical oxidation technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a hundred thousand.

Table 4–30 Accident Frequencies, Process Durations, and Consequences for Accidents with Filter Media Residues

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
IDC 331 Ful Flo Filter Media									
Alternative 1 (No Action) Neutralize, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.24	439	0.00022	5,120	2.6	3,420	0.0014
Alternative 2 (without Plutonium Separation) **Blend Down at Rocky Flats**	**Earthquake (Bldg. 371)**	**0.000094**	**0.19**	**555**	**0.00028**	**6,480**	**3.2**	**4,320**	**0.0017**
	Earthquake (Bldg. 707) [b]	**0.0026**	**0.19**	**370**	**0.00019**	**6,480**	**3.2**	**4,320**	**0.0017**
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.13	544	0.00027	6,350	3.2	4,230	0.0017
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371) [c]	0.000094	0.07	1,590	0.00080	18,500	9.3	12,400	0.0050
	Earthquake (Bldg. 707A) [d]	0.0026	0.08	570	0.00029	11,900	6.0	9,980	0.0040
IDC 338 High-Efficiency Particulate Air Filter Media									
Alternative 1 (No Action) Neutralize, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	1.13	439	0.00022	5,120	2.6	3,420	0.0014
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.21	914	0.00046	16,000	8.0	10,700	0.0043
Blend Down at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.90	555	0.00028	6,480	3.2	4,320	0.0017
	Earthquake (Bldg. 707) [b]	0.0026	0.90	370	0.00019	6,480	3.2	4,320	0.0017
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.58	544	0.00027	6,350	3.2	4,230	0.0017
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371) [c]	0.000094	0.31	1,590	0.00080	18,500	9.3	12,400	0.0050
	Earthquake (Bldg. 707A) [d]	0.0026	0.38	570	0.00029	11,900	6.0	9,980	0.0040
Alternative 4 (Combination) **Neutralize and Dry at Rocky Flats**	**Earthquake (Bldg. 371)**	**0.000094**	**1.13**	**439**	**0.00022**	**5,120**	**2.6**	**3,420**	**0.0014**

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Other High-Efficiency Particulate Air Filter Media									
Alternative 1 (No Action)									
Neutralize, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.02	439	0.00022	5,120	2.6	3,420	0.0014
Alternative 2 (without Plutonium Separation)									
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.01	914	0.00046	16,000	8.0	10,700	0.0043
Blend Down at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.02	555	0.00028	6,480	3.2	4,320	0.0017
	Earthquake (Bldg. 707) [b]	0.0026	0.02	370	0.00019	6,480	3.2	4,320	0.0017
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.01	544	0.00027	6,350	3.2	4,230	0.0017
Alternative 3 (with Plutonium Separation)									
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371) [c]	0.000094	0.01	1,590	0.00080	18,500	9.3	12,400	0.0050
	Earthquake (Bldg. 707A) [d]	0.0026	0.01	570	0.00029	11,900	6.0	9,980	0.0040
Alternative 4 (Combination) **Repackage at Rocky Flats**	**Earthquake (Bldg. 707)**	**0.0026**	**0.021**	**353**	**0.00018**	**6,170**	**3.1**	**4,120**	**0.0016**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[a] Building 707 is designated as an alternate location for the Shred and Blend Down process at Rocky Flats.
[b] Mediated electrochemical oxidation process in Building 371.
[c] Final calcination process in Building 707A.
Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–31 Risks Due to Accidents with Filter Media Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
IDC 331 Ful Flo Filter Media				
Alternative 1 (No Action)				
Neutralize, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	4.9×10^{-9}	0.000058	3.1×10^{-8}
	Composite	7.0×10^{-9}	0.000082	4.3×10^{-8}
Alternative 2 (without Plutonium Separation)				
Blend Down at Rocky Flats	**Earthquake (Bldg. 371)**	**5.0×10^{-9}**	**0.000058**	**3.1×10^{-8}**
	Composite (Bldg. 371)	**7.0×10^{-9}**	**0.000082**	**4.4×10^{-8}**
	Earthquake (Bldg. 707) [b]	**9.1×10^{-8}**	**0.0016**	**8.5×10^{-7}**
	Composite (Bldg. 707) [b]	**9.3×10^{-8}**	**0.0016**	**8.7×10^{-7}**
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	3.3×10^{-9}	0.000039	2.1×10^{-8}
	Composite	4.7×10^{-9}	0.000055	2.9×10^{-8}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371)	5.2×10^{-9}	0.000061	3.3×10^{-8}
	Composite	1.0×10^{-8}	0.00011	4.7×10^{-8}
	Earthquake (Bldg. 707A)	5.9×10^{-8}	0.0012	8.3×10^{-7}
	Composite	6.0×10^{-8}	0.0013	8.4×10^{-7}
IDC 338 High-Efficiency Particulate Filter Media				
Alternative 1 (No Action)				
Neutralize, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	2.3×10^{-8}	0.00027	1.4×10^{-7}
	Composite	3.3×10^{-8}	0.00038	2.1×10^{-7}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	2.5×10^{-7}	0.00044	2.3×10^{-6}
	Composite	2.5×10^{-7}	0.00044	2.4×10^{-6}
Blend Down at Rocky Flats	Earthquake (Bldg. 371)	2.3×10^{-8}	0.00027	1.5×10^{-7}
	Composite (Bldg. 371)	3.3×10^{-8}	0.00039	2.1×10^{-7}
	Earthquake (Bldg. 707) [b]	4.3×10^{-7}	0.0076	4.0×10^{-6}
	Composite (Bldg. 707) [b]	4.4×10^{-7}	0.0077	4.1×10^{-6}
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	1.5×10^{-8}	0.00017	9.2×10^{-8}
	Composite	2.1×10^{-8}	0.00024	1.3×10^{-7}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371)	2.3×10^{-8}	0.00027	1.4×10^{-7}
	Composite	4.5×10^{-8}	0.00049	2.1×10^{-7}
	Earthquake (Bldg. 707A)	2.8×10^{-7}	0.0059	4.0×10^{-6}
	Composite	2.9×10^{-7}	0.0060	4.2×10^{-6}

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 4 (Combination)				
Neutralize and Dry at Rocky Flats	**Earthquake (Bldg. 371)**	**2.3×10^{-8}**	**0.00027**	**1.4×10^{-7}**
	Composite	**3.3×10^{-8}**	**0.00038**	**2.1×10^{-7}**
Other High-Efficiency Particulate Air Filter Media				
Alternative 1 (No Action)				
Neutralize, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	4.1×10^{-10}	4.8×10^{-6}	2.6×10^{-9}
	Composite	5.8×10^{-10}	6.8×10^{-6}	3.6×10^{-9}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats (High-Efficiency Particulate Air only)	Earthquake (Bldg. 707)	1.2×10^{-8}	0.00021	1.1×10^{-7}
	Composite	1.2×10^{-8}	0.00021	1.1×10^{-7}
Blend Down at Rocky Flats	Earthquake (Bldg. 371)	5.2×10^{-10}	6.1×10^{-6}	3.2×10^{-9}
	Composite (Bldg. 371)	7.4×10^{-10}	8.6×10^{-6}	4.6×10^{-9}
	Earthquake (Bldg. 707) [b]	9.6×10^{-9}	0.00017	9.0×10^{-8}
	Composite (Bldg. 707) [b]	9.8×10^{-9}	0.00017	9.2×10^{-8}
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	2.6×10^{-10}	3.0×10^{-6}	1.6×10^{-9}
	Composite	3.6×10^{-10}	4.2×10^{-6}	2.2×10^{-9}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371)	7.5×10^{-10}	8.7×10^{-6}	4.7×10^{-9}
	Composite	1.4×10^{-9}	0.000016	6.7×10^{-9}
	Earthquake (Bldg. 707A)	7.4×10^{-9}	0.00015	1.0×10^{-7}
	Composite	7.5×10^{-9}	0.00016	1.1×10^{-7}
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (bldg. 707)**	**9.6×10^{-9}**	**0.00017**	**9.0×10^{-8}**
	Composite (bldg. 707)	**9.8×10^{-9}**	**0.00017**	**9.1×10^{-8}**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Building 707 is designated as an alternate location for the Shred and Blend Down process at Rocky Flats.
Note: The impacts due to the preferred processing technology are presented in bold type.

- **Other Filter Media** - The highest consequences to all three receptors would occur if DOE decides to implement the mediated electrochemical oxidation technology at Rocky Flats and a major earthquake occurs strong enough to collapse Building 371 during the processing of the residues prior to final calcination.

  The highest risk to the public maximally exposed individual is estimated to be 1.2×10^{-8} and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the vitrification technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten million. The highest risk to the public population is estimated at 0.00021 and would also occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the vitrification technology. The highest risk to the noninvolved worker is estimated to be 1.1×10^{-7} and would occur due to the same accident as for the maximally exposed individual and public population. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a million.

4.7 IMPACTS OF MANAGING SLUDGE RESIDUES

The inventory of sludge residues weighs 619 kg (1,364 lb), including 26.7 kg (58.9 lb) of plutonium. The entire inventory is stored in 54 drums (with about 270 internal metal containers) and 34 other small individual containers.

As discussed in Chapter 2, the alternatives for sludge residues include one technology under the No Action Alternative, two technologies under the Process without Plutonium Separation Alternative, one technology under the Process with Plutonium Separation Alternative, and one technology under Alternative 4. The preferred processing technology is to filter/dry the residue at Rocky Flats. A small portion of the sludge residue inventory (7 kg [15 lb]) is broken out into a separate subcategory because no processing technology is available for this material under the Process With Plutonium Separation Alternative and it has a different technology under Alternative 4.

This section presents the environmental impacts of managing the entire inventory of sludge residues under each of the technlogies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.7.1 Products and Wastes

Every processing technology for sludge residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at Rocky Flats. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed in WIPP as transuranic waste.

High-level waste and saltstone will not be generated from sludge residues because none of the technologies involve shipping the residues to the Savannah River Site for plutonium separation. If plutonium is separated at Rocky Flats, it would be stored securely onsite until a decision is made on its disposition. No increase in

proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. This separated plutonium would also contain the americium from the sludge residues.

The solid plutonium-bearing products and wastes that would be generated from sludge residues under each of the technologies are presented in **Table 4–32**. The shaded areas of Table 4–32 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technologies are presented in bold type. The largest amount of transuranic waste (653 drums) would be generated in the dissolve and oxidize technology. The two technlogies under Alternative 2 would generate only about one-third as much transuranic waste. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate over 1,100 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantity of low-level waste would also be highest under the dissolve and oxidize technology, and much lower under all the other technologies. The site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from sludge residues is 25 kg (55 lb).

4.7.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the alternatives associated with the management of sludge residues. These impacts are presented for incident-free operation and postulated accident scenarios, respectively. The detailed site analyses are presented in Appendix D. No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.7.2.1 Incident-Free Operations

- **Radiological Impacts—**The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–33**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of sludge residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing.

  The highest estimated public maximally exposed individual dose in Table 4–33 is 7.3×10^{-6} mrem, which would occur during the acid dissolve process at Rocky Flats. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one-hundred billion. The highest public population radiation dose listed in Table 4–33 would also occur for the acid dissolve process, if DOE decides to implement this technology. This dose is estimated to be 0.00016 person-rem, which would cause far less than one additional latent fatal cancer among the population living near Rocky Flats.

  The highest involved worker population radiation dose would be 38 person-rem, which would occur if DOE decides to implement the acid dissolve technology. This dose would cause 0.015 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- **Hazardous Chemical Impacts—**The impacts of exposure to hazardous chemicals from the processing of sludge residues at Rocky Flats were not evaluated because hazardous chemicals are not expected to be released from the proposed operations at this site.

Table 4–32 Products and Wastes from Sludge Residues

	Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*High-Level Waste (Canisters of Glass)* [b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)* [a]	*Saltstone (cubic meters)*
IDC 089, 099 and 332 Sludge Residues						
Alternative 1 (No Action) Filter/Dry and Store at Rocky Flats	45	2			1	
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats		3			1	
Blend Down at Rocky Flats		8			1	
Alternative 4 (Combination) **Repackage at Rocky Flats**	**6** [d]	**2**			**1**	
Other Sludge Residues						
Alternative 1 (No Action) Filter/Dry and Store at Rocky Flats	1,095	60			127	
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats		216			127	
Blend Down at Rocky Flats		212			127	
Alternative 3 (with Plutonium Separation) Dissolve and Oxidize at Rocky Flats		653		25	1,468	
Alternative 4 (Combination) **Filter/Dry at Rocky Flats**	**1,095**[d]	**60**			**127**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The storage capacities at each site are adequate to store the products and wastes listed in this table. The impacts due to the preferred processing technologies are presented in bold type.

Table 4–33 Radiological Impacts Due to Incident-Free Management of Sludge Residues

	Offsite Public Maximally Exposed Individual Risk		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem/yr)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Cancer Incidences*
IDC 089, 099 and 332 Sludge Residues								
Alternative 1 (No Action) Filter, Dry and Store at Rocky Flats	1.4×10^{-7}	7.0×10^{-14}	2.8×10^{-6}	1.4×10^{-9}	2,000	0.0008	1.0	0.00040
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	4.6×10^{-8}	2.3×10^{-14}	1.9×10^{-6}	9.5×10^{-10}	2,000	0.0008	0.23	0.000092
Blend Down at Rocky Flats	3.8×10^{-8}	1.9×10^{-14}	1.6×10^{-6}	8.0×10^{-10}	2,000	0.0008	0.23	0.000092
Alternative 4 (Combination) **Repackage at Rocky Flats**	**4.0×10^{-8}**	**2.0×10^{-14}**	**1.6×10^{-6}**	**8.0×10^{-10}**	**2,000**	**0.0008**	**0.18**	**0.000072**
Other Sludge Residues								
Alternative 1 (No Action) Filter, Dry and Store at Rocky Flats	3.6×10^{-6}	1.8×10^{-12}	0.000077	3.9×10^{-8}	2,000	0.0008	25	0.010
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	1.3×10^{-6}	6.5×10^{-13}	0.000050	2.5×10^{-8}	2,000	0.0008	6.4	0.0026
Blend Down at Rocky Flats	3.6×10^{-6}	1.8×10^{-12}	0.000077	3.9×10^{-8}	2,000	0.0008	6.4	0.0026
Alternative 3 (with Plutonium Separation) Acid Dissolve at Rocky Flats	7.3×10^{-6}	3.7×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	38	0.015
Alternative 4 (Combination) **Filter and Dry at Rocky Flats**	**3.6×10^{-6}**	**1.8×10^{-12}**	**0.000077**	**3.9×10^{-8}**	**2,000**	**0.0008**	**11**	**0.0044**

Note: The impacts due to the preferred processing technology are presented in bold type.

4.7.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with sludge residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–34**. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–33, for each of the sludge residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The highest consequences to all three receptors for sludge residues other than IDC 089, 099 and 332, would occur if DOE decides to implement the blend down technology and a major earthquake strong enough to cause the breach of Building 371 occurs during the 0.062 years of residue processing at Rocky Flats.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–35**, for each of the four sludge residue processing technologies. The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented.

The highest risk to the public maximally exposed individual for sludge residues other than IDC 089, and 99 and 332, is estimated to be 1.2×10^{-7}, which is due to an earthquake during processing of the residue with the blend down technology in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.0022 latent cancer fatalities, which is also due to an earthquake during processing of the residue with the blend down technology in Building 707. The highest risk to the individual noninvolved onsite worker is estimated to be 1.1×10^{-6}, which is due to the same accident scenario in the same technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a hundred thousand.

4.8 IMPACTS OF MANAGING GLASS RESIDUES

The inventory of glass residues weighs 134 kg (295 lb), including 5.1 kg (11.2 lb) of plutonium. The entire inventory is stored in 10 drums with no internal metal containers.

Table 4–34 Accident Frequencies, Process Durations, and Consequences for Accidents with Sludge Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
IDC 089, 099 and 332 Sludge Residues									
Alternative 1 (No Action)									
Filter, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.01	521	0.00026	6,080	3.0	4,050	0.0016
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [b]	0.00005	0.002	960	0.00048	16,800	8.4	11,200	0.0045
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [c]	0.0026	0.002	914	0.00046	16,000	8.0	10,700	0.0043
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.035	105	0.000053	1,830	0.9	1,220	0.00049
	Earthquake (Bldg. 371) [d]	0.000094	0.035	157	0.000079	1,830	0.9	1,220	0.00049
Alternative 4 (Combination)									
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.015**	**228**	**0.00011**	**4,000**	**2.0**	**2,670**	0.0011
Other Sludge Residues									
Alternative 1 (No Action)									
Filter, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.20	692	0.00035	8,070	4.0	5,380	0.0022
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [b]	0.00005	0.062	960	0.00048	16,800	8.4	11,200	0.0045
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [c]	0.0026	0.062	914	0.00046	16,000	8.0	10,700	0.0043
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.062	1,520	0.00076	26,700	13	17,800	0.0071
	Earthquake (Bldg. 371) [d]	0.000094	0.062	2,290	0.0011	26,700	13	17,800	0.0071
Alternative 3 (with Plutonium Separation)									
Dissolve and Oxidize at Rocky Flats	Criticality (Bldg. 371) [e]	0.0001	0.88	790	0.00040	6,980	3.5	321	0.00013
	Earthquake (Bldg. 707A) [f]	0.0026	0.061	760	0.00038	15,800	7.9	13,300	0.0053
Alternative 4 (Combination)									
Filter and Dry at Rocky Flats	**Earthquake (Bldg. 371)**	**0.000094**	**0.20**	**692**	**0.00035**	**8,070**	**4.0**	**5,380**	**0.0022**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Highest consequence accident for this processing technology.
[c] Highest risk accident for this processing technology.
[d] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.
[e] Acid dissolution process in Building 371.
[f] Final calcination process in Building 707A.
Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–35 Risks Due to Accidents with Sludge Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
IDC 089, 099 and 332 Sludge Residues				
Alternative 1 (No Action)				
Filter, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	2.5×10^{-10}	2.9×10^{-6}	1.5×10^{-9}
	Composite	4.0×10^{-10}	4.6×10^{-6}	2.5×10^{-9}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	2.4×10^{-9}	0.000042	2.2×10^{-8}
	Composite	2.5×10^{-9}	0.000043	2.3×10^{-8}
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	4.8×10^{-9}	0.000083	4.4×10^{-8}
	Composite (Bldg. 707)	5.8×10^{-9}	0.00010	5.4×10^{-8}
	Earthquake (Bldg. 371) [b]	2.6×10^{-10}	3.0×10^{-6}	1.6×10^{-9}
	Composite (Bldg. 371) [b]	5.5×10^{-10}	6.4×10^{-6}	3.4×10^{-9}
Alternative 4 (Combination)	**Earthquake (Bldg. 707)**	**4.5×10^{-9}**	**0.000078**	**4.2×10^{-8}**
Repackage at Rocky Flats	**Composite (Bldg. 707)**	**4.7×10^{-9}**	**0.000083**	**4.4×10^{-8}**
Other Sludge Residues				
Alternative 1 (No Action)				
Filter, Dry and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	6.5×10^{-9}	0.000076	4.0×10^{-8}
	Composite	1.0×10^{-8}	0.00012	6.4×10^{-8}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	7.4×10^{-8}	0.0013	6.9×10^{-7}
	Composite	7.7×10^{-8}	0.0013	7.1×10^{-7}
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	1.2×10^{-7}	0.0022	1.1×10^{-6}
	Composite (Bldg. 707)	1.3×10^{-7}	0.0022	1.2×10^{-6}
	Earthquake (Bldg. 371) [b]	6.6×10^{-9}	0.000078	4.1×10^{-8}
	Composite (Bldg. 371) [b]	9.7×10^{-9}	0.00011	6.0×10^{-8}
Alternative 3 (with Plutonium Separation)				
Dissolve and Oxidize at Rocky Flats	Criticality (Bldg. 371) [c]	3.5×10^{-8}	0.00031	1.1×10^{-8}
	Composite	4.3×10^{-8}	0.00042	8.1×10^{-8}
	Earthquake (Bldg. 707A) [d]	6.0×10^{-8}	0.0013	8.4×10^{-7}
	Composite	6.2×10^{-8}	0.0013	6.0×10^{-7}
Alternative 4 (Combination)				
Filter and Dry at Rocky Flats	**Earthquake (Bldg. 371)**	**6.5×10^{-9}**	**0.000076**	**4.0×10^{-8}**
	Composite	**1.0×10^{-8}**	**0.00012**	**6.4×10^{-8}**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[a] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.
[b] Acid dissolution process in Building 371.
[c] Final calcination process in Building 707A.
Note: The impacts due to the preferred processing technology are presented in bold type.

As discussed in Chapter 2, the alternatives for glass residues include one technology under the No Action Alternative, three technologies under the Process without Plutonium Separation Alternative, one technology under the Process with Plutonium Separation Alternative and one technology under Alternative 4. The preferred processing technology is to neutralize and dry the glass residues at Rocky Flats.

This section presents the environmental impacts of managing the entire inventory of glass residues under each of the six technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.8.1 Products and Wastes

Every processing technology for glass residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at Rocky Flats. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues, containing plutonium in excess of the safeguards termination limits. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone will not be generated from glass residues because none of the technologies involve shipping the residues to the Savannah River Site for plutonium separation. If plutonium is separated at Rocky Flats, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. This separated plutonium would also contain the americium from glass residues.

The solid plutonium-bearing products and wastes that would be generated from glass residues under each of the technologies are presented in **Table 4–36**. The shaded areas of Table 4–36 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (145 drums) would be generated in the mediated electrochemical oxidation technology. The three technologies under Alternative 2 would generate only about one-third as much transuranic waste. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate only 18 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantity of low-level waste would also be highest under the mediated electrochemical oxidation technology, and much lower under all the other technologies. The site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from glass residues is 5 kg (11 lb).

4.8.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of glass residues. These impacts are presented for incident-free operation and postulated accident scenarios, respectively. The detailed site analyses are presented in Appendix D.

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be

extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

Table 4–36 Products and Wastes from Glass Residues

	Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*High-Level Waste (Canisters of Glass)* [b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)* [a]	*Saltstone (cubic meters)*
Alternative 1 (No Action) Neutralize, Dry and Store at Rocky Flats	7	11			27	
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats		41			27	
Blend Down at Rocky Flats		41			27	
Sonic Wash at Rocky Flats		48			27	
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats		145		5	321	
Alternative 4 (Combination) **Neutralize and Dry at Rocky Flats**	**7**[d]	**11**			**27**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes:
Shaded areas indicate the types of solid products and waste that would not be generated; the products and wastes from the preferred processing technology are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

4.8.2.1 Incident-Free Operations

- **Radiological Impacts—**The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–37**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of Raschig ring and glass residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing.

  The highest estimated public maximally exposed individual dose in Table 4–37 is 1.8×10^{-6} mrem, which would occur during the mediated electrochemical oxidation process at Rocky Flats. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one trillion. The highest public population radiation dose listed in Table 4–37 would also occur for the mediated electrochemical oxidation process, if DOE decides to implement this technology. This dose is estimated to be 0.000038 person-rem, which would cause far less than one additional latent fatal cancer among the population living near Rocky Flats.

  The highest total involved worker population radiation dose would be 1.9 person-rem, which would occur if DOE decides to implement either the sonic wash or mediated electrochemical oxidation technology. This dose would cause far less than one additional latent fatal cancer among the workers directly involved in either operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- **Hazardous Chemical Impacts—**The impacts of exposure to hazardous chemicals from the processing of glass residues at Rocky Flats were not evaluated because hazardous chemicals are not expected to be released from the proposed operations at this site.

4.8.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with glass residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–38**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accident during post-emergency interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

Table 4–37 Radiological Impacts Due to Incident-Free Management of Glass Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	***Probability of Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem/yr)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Alternative 1 (No Action)								
Neutralize, Dry and Store at Rocky Flats	N/E	–	N/E	–	2,000	0.0008	1.6	0.00064
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	2.1×10^{-7}	1.0×10^{-13}	8.6×10^{-6}	4.3×10^{-9}	2,000	0.0008	1.0	0.00040
Blend Down at Rocky Flats	7.1×10^{-7}	3.6×10^{-13}	0.000015	7.5×10^{-9}	2,000	0.0008	1.1	0.00044
Sonic Wash at Rocky Flats	N/E	–	N/E	–	2,000	0.0008	1.9	0.00076
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	1.8×10^{-6}	9.0×10^{-13}	0.000038	1.9×10^{-8}	2,000	0.0008	1.9	0.00076
Alternative 4 (Combination)								
Neutralize and Dry at Rocky Flats	**N/E**	**–**	**N/E**	**–**	**2,000**	**0.0008**	**1.5**	**0.00060**

N/E = no emissions—therefore, there are no radiological impacts to the public
Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–38 Accident Frequencies, Process Durations, and Consequences for Accidents with Glass Residues

	Accident Scenario	Accident Frequency (per year)	Process Duration (years)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
				Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Alternative 1 (No Action)									
Neutralize, Dry, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.037	754	0.00038	8,800	4.4	5,870	0.0024
Alternative 2 (without Plutonium Separation)									
Vitrify at Rocky Flats	Explosion (Bldg. 707) [b]	0.00005	0.012	960	0.00048	16,800	8.4	11,200	0.0045
	Earthquake (Bldg. 707) [c]	0.0026	0.012	914	0.00046	16,000	8.0	10,700	0.0043
Blend Down at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.014	2,000	0.0010	23,300	12	15,600	0.0062
	Earthquake (Bldg. 707) [d]	0.0026	0.014	1,330	0.00067	23,300	23	15,600	0.0062
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.037	453	0.00023	5,280	2.6	3,520	0.0014
Alternative 3 (with Plutonium Separation)									
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371) [e]	0.000094	0.019	1,480	0.00074	17,200	8.6	11,500	0.0046
	Earthquake (Bldg. 707A) [f]	0.0026	0.0064	1,400	0.00070	29,100	15	24,400	0.020
Alternative 4 (Combination)									
Neutralize and Dry at Rocky Flats	**Earthquake (Bldg. 371)**	**0.000094**	**0.037**	**754**	**0.00038**	**8,800**	**4.4**	**5,870**	**0.0024**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Highest consequence accident for this processing technology.
[c] Highest risk accident for this processing technology.
[d] Building 707 is designated as an alternate location for the Blend Down process at Rocky Flats.
[e] Mediated electrochemical oxidation process in Building 371.
[f] Final calcination process in Building 707A.
Note: The impacts due to the proposed processing technology are presented in bold type.

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–38, for each of the six glass residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequences to the maximally exposed individual would occur if DOE decides to implement the blend down technology and a major earthquake strong enough to cause the breach of Building 371 occurs during the 0.014 years of residue processing at Rocky Flats. The highest consequences to the public population would occur if DOE decides to implement the blend down technology and a major earthquake strong enough to cause the breach of Building 707 occurs during the 0.014 years of residue processing at Rocky Flats. The highest consequences to the noninvolved onsite worker would occur if DOE decides to implement the mediated electrochemical oxidation technology and a major earthquake strong enough to cause the breach of Building 707A occurs during the final calcination process at Rocky Flats.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–39**, for each of the five glass residue processing technologies. The risk associated with the highest risk accident and a composite risk due to all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 2.4×10^{-8}, which is due to an earthquake during processing of the residue in Building 707 with the blend down technology at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten million. The highest risk to the public population is estimated to be 0.00042 latent cancer fatalities, which is also due to an earthquake during processing of the residue with the blend down technology. The highest risk to the individual noninvolved onsite worker is estimated to be 3.3×10^{-7}, which is due to a major earthquake strong enough to cause the collapse of Building 707A during the final calcination for the mediated electrochemical oxidation process at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a million.

Table 4–39 Risks Due to Accidents with Glass Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Neutralize, Dry, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	1.3×10^{-9}	0.000015	8.2×10^{-9}
	Composite	1.9×10^{-9}	0.000022	1.2×10^{-8}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.4×10^{-8}	0.00025	1.3×10^{-7}
	Composite	1.5×10^{-8}	0.00026	1.4×10^{-7}
Blend Down at Rocky Flats	Earthquake (Bldg. 371)	1.3×10^{-9}	0.000015	8.2×10^{-9}
	Composite (Bldg. 371)	1.9×10^{-9}	0.000022	1.2×10^{-8}
	Earthquake (Bldg. 707) [b]	2.4×10^{-8}	0.00042	2.3×10^{-7}
	Composite (Bldg. 707) [b]	2.5×10^{-8}	0.00044	2.3×10^{-7}
Sonic Wash at Rocky Flats	Earthquake (Bldg. 371)	7.9×10^{-10}	9.2×10^{-6}	4.9×10^{-9}
	Composite	1.1×10^{-9}	0.000013	6.9×10^{-9}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371) [c]	1.3×10^{-9}	0.000015	8.2×10^{-9}
	Composite	2.6×10^{-9}	0.000028	1.2×10^{-8}
	Earthquake (Bldg. 707A) [d]	1.2×10^{-8}	0.00024	3.3×10^{-7}
	Composite	1.2×10^{-8}	0.00025	3.3×10^{-7}
Alternative 4 (Combination)				
Neutralize and Dry at Rocky Flats	**Earthquake (Bldg. 371)**	$\mathbf{1.3\times10^{-9}}$	**0.000015**	$\mathbf{8.2\times10^{-9}}$
	Composite	$\mathbf{1.9\times10^{-9}}$	**0.000022**	$\mathbf{1.2\times10^{-8}}$

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Building 707 is designated as an alternate location for the Blend Down process at Rocky Flats.
[c] Mediated electrochemical oxidation process in Building 371.
[d] Final calcination process in Building 707A.
Note: The impacts due to the proposed processing technology are presented in bold type.

4.9 IMPACTS OF MANAGING GRAPHITE RESIDUES

The inventory of graphite residues weighs 1,880 kg (4,141 lb), including 97.4 kg (214.7 lb) of plutonium. The entire inventory is stored in 106 drums (with about 530 internal metal containers) and 39 small individual containers.

As discussed in Chapter 2, the alternatives for graphite residues include one technology under the No Action Alternative, three technologies under the Process without Plutonium Separation Alternative, two technologies under the Process with Plutonium Separation Alternative, and one technology under Alternative 4. The preferred processing technology is to repackage the graphite residues at Rocky Flats.

This section presents the environmental impacts of managing the entire inventory of graphite residues under each of the seven technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.9.1 Products and Wastes

Every processing technology for graphite residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues, containing plutonium in excess of the safeguards termination limits. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then these stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone would be generated only at the Savannah River Site if the residues were shipped to that site for plutonium separation. The final form for the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a by-product of Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults. If plutonium is separated at Rocky Flats or the Savannah River Site, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. Any plutonium separated at Rocky Flats would contain americium, while at the Savannah River Site the americium would go into the high-level waste.

The solid plutonium-bearing products and wastes that would be generated from graphite residues under each of the technologies are presented in **Table 4–40**. The shaded areas of Table 4–40 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (over 2,000 drums) would be generated in the technology to perform mediated electrochemical oxidation at Rocky Flats. The three technologies under Alternative 2 would each generate only about one-third as much transuranic waste as would the technology to perform mediated electrochemical oxidation at Rocky Flats, under Alternative 3. The other technology under Alternative 3 (preprocess at Rocky Flats, then mediated electrochemical oxidation and Purex at Savannah River Site) would only generate 119 drums of transuranic waste. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic

waste. Thus, this technology would generate almost 750 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantity of low-level waste generated (almost 4,500 drums) would also be highest

Table 4–40 Products and Wastes from Graphite Residues

	Stabilized Residues[a] (Drums)	*Transuranic Waste (Drums)[a]*	*High-Level Waste (Canisters of Glass)[b]*	*Separated Plutonium (kg)[c]*	*Low-Level Waste (Drums)[a]*	*Saltstone (cubic meters)*
Alternative 1 (No Action)						
Repackage and Store at Rocky Flats	575	171			376	
Alternative 2 (without Plutonium Separation)						
Cement at Rocky Flats		756			376	
Vitrify at Rocky Flats		650			153	
Blend Down at Rocky Flats		650			153	
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats		2,055		95	4,495	
Preprocess at Rocky Flats		75	–	–	153	–
Mediated Electrochemical Oxidation/Purex at Savannah River Site		44	8	96	63	104
Alternative 4 (Combination)						
Repackage at Rocky Flats	**575[d]**	**171**			**376**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Note: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technology are presented in bold type. The storage capacities at each site are adequate to store the products and wastes in this table.

under the mediated electrochemical oxidation technology at Rocky Flats, and would be much lower under all the other technologies. The site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from graphite residues is 96 kg (212 lb).

4.9.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the alternatives associated with the management of graphite residues. These impacts are presented for incident-free operation and postulated accident scenarios. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship the graphite residues to the Savannah River Site for mediated electrochemical oxidation/Purex processing, then 16 shipments would be required and the total round-trip shipping distance would be 83,700 km (51,900 mi).

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.9.2.1 Incident-Free Operations

Radiological Impacts—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–41**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of graphite residues. The length of time necessary to process the graphite residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

The highest estimated public maximally exposed individual risk in Table 4–41 is 11 mrem, which could occur only during transportation. This hypothetical individual's cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–41 would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site. The sum of these doses is 1.6 person-rem, which would cause far less than one additional cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

The highest involved worker population radiation dose would be approximately 43 person-rem, which would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site. This dose would cause 0.017 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be much smaller than the impacts to the involved workers.

Table 4–41 Radiological Impacts Due to Incident-Free Management of Graphite Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Individual Involved Worker Population*	
	Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem/yr)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Alternative 1 (No Action)								
Repackage and Store at Rocky Flats	N/E	–	N/E	–	2,000	0.0008	25	0.010
Alternative 2 (without Plutonium Separation)								
Cement at Rocky Flats	2.8×10^{-6}	1.4×10^{-12}	0.00060	3.0×10^{-7}	2,000	0.0008	34	0.014
Vitrify at Rocky Flats	4.0×10^{-6}	2.0×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	19	0.0076
Blend Down at Rocky Flats	0.000014	6.8×10^{-12}	0.00028	1.4×10^{-7}	2,000	0.0008	19	0.0076
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	0.000034	1.7×10^{-11}	0.00072	3.6×10^{-7}	2,000	0.0008	36	0.014
Preprocess at Rocky Flats	6.9×10^{-6}	3.4×10^{-12}	0.00015	7.5×10^{-8}	2,000	0.0008	15	0.0060
Transport to Savannah River Site	11	5.5×10^{-6}	1.6	0.0008	100	0.00004	2.5	0.0010
Mediated Electrochemical Oxidation/Purex at Savannah River Site[a]	0.00012	6.0×10^{-11}	0.014	7.0×10^{-6}	2,000	0.0008	25	0.010
Alternative 4 (Combination)								
Repackage at Rocky Flats	**N/E**	**–**	**N/E**	**–**	**2,000**	**0.0008**	**18**	**0.0072**

N/E = no emissions—therefore, there are no radiological impacts to the public

[a] Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

Note: The impacts due to the preferred processing technology are presented in bold type.

Hazardous Chemical Impacts—The processing of graphite residues at Rocky Flats would not involve airborne releases of hazardous chemicals. No carcinogenic chemicals would be released from the mediated electrochemical oxidation process at Savannah River Site. Noncancer health risks resulting from releases of phosphoric acid and ammonium nitrate are low; the Hazard Index values presented in **Table 4–42** are much less than one. The impacts due to the preferred processing technology are presented in bold type.

4.9.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with graphite residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–43**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to Savannah River Site. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–43, for each of the seven graphite residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The highest consequences to the maximally exposed individual and public population would occur if DOE decides to implement the mediated electrochemical oxidation/Purex technology at the Savannah River Site and a major earthquake strong enough to cause the breach of Building 371 occurs during the 0.22 years of processing at Rocky Flats. The highest consequences to the noninvolved onsite worker would occur if DOE decides to implement the mediated electrochemical oxidation/Purex technology at the Savannah River Site and a major earthquake strong enough to cause the breach of the H-Canyon occurs during the 0.42 years of processing at the Savannah River Site.

Table 4–42 Chemical Impacts Due to Incident-Free Management of Graphite Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of a Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities*[a]	*Probability of a Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities*[a]
Alternative 1 (No Action)						
Repackage and Store at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Cement at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Vitrify at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Blend Down at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Preprocess at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00021[c]	N/A	N/A	(c)
Mediated Electrochemical Oxidation/Purex at Savannah River Site[d, e]	N/E	2×10^{-9}	N/E	N/E	2×10^{-8}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**

N/E = no emissions N/A = not applicable—the maximally exposed individual is undefined for vehicle emissions

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from this process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively. However, the risk to the public dominates. See Appendix E, Section E.4 for additional information.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–43 Accident Frequencies, Process Durations, and Consequences for Accidents with Graphite Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (Person-rem)*	*Number of Latent Cancer or Traffic Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Alternative 1 (No Action)									
Repackage and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	0.23	1,520	0.00076	26,700	13	17,800	0.0071
Alternative 2 (without Plutonium Separation)	Earthquake (Bldg. 371)	0.000094	0.32	1,000	0.00050	11,700	5.9	7,780	0.0031
Cement at Rocky Flats	Explosion (Bldg. 707)[b, c]	0.00005	0.32	960	0.00048	16,800	8.4	11,200	0.0045
	Earthquake (Bldg. 707) [c]	0.0026	0.32	667	0.00033	11,700	5.9	7,780	0.0031
Vitrify at Rocky Flats	Explosion (Bldg. 707) [b]	0.00005	0.23	960	0.00048	16,800	8.4	11,200	0.0045
	Earthquake (Bldg. 707) [d]	0.0026	0.23	914	0.00046	16,000	8.0	10,700	0.0043
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.23	1,520	0.00076	26,700	13	17,800	0.0071
	Earthquake (Bldg. 371) [e]	0.000094	0.23	2,290	0.0011	26,700	13	17,800	0.0071
Alternative 3 (with Plutonium Separation)	Earthquake (Bldg. 371) [f]	0.000094	0.33	1,580	0.00079	18,500	9.3	12,300	0.0049
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 707A) [g]	0.0026	0.31	570	0.00029	11,900	6.0	9,980	0.0040
Preprocess at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.22	2,470	0.0012	28,800	14	19,200	0.0077
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	16 shipments	N/A	N/A	N/A	1.0 [h]	N/A	(i)
Mediated Electrochemical Oxidation/ Purex at Savannah River Site	Earthquake (H-Canyon) [j]	0.000182	0.42	65	0.000033	2,930	1.5	20,800	0.017
Alternative 4 (Combination)									
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.23**	**1,520**	**0.00076**	**26,700**	**13**	**17,800**	**0.0071**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Highest consequence accident for this processing technology.

[c] Building 707 is designated as an alternate location for the Cement process at Rocky Flats.

[d] Highest risk accident for this processing technology.

[e] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[f] Mediated electrochemical oxidation process in Building 371.

[g] Final calcination process in Building 707A.

[h] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list in a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[i] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

[j] HB-Line operates 60 percent of the time. Dose estimates assumed the HB-Line was operating at the time of the accident.

Note: The impacts due to the preferred processing technology are presented in bold type.

The risks associated with each accident are calculated by multiplying the probability by the consequences. The risks to the public and an onsite worker are presented in **Table 4–44**, for each of the six graphite residue processing technologies. The risk associated with the highest risk accident and a composite risk due to all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 4.6×10^{-7}, which is due to an earthquake during processing of the residue with the repackage (under Alternatives 1 or 4) or the blend down technology in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.0080 latent cancer fatalities, which is also due to an earthquake during processing of the residue with either the repackage or the blend down technology in Building 707. The highest risk to the individual noninvolved onsite worker is estimated to be 4.3×10^{-6}, which is also due to an earthquake during processing of the residue with either the repackage or the blend down technology in Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

4.10 IMPACTS OF MANAGING INORGANIC RESIDUES

The inventory of inorganic residues weighs 448 kg (988 lb), including 17.7 kg (39 lb) of plutonium. The entire inventory is stored in 44 drums (with no internal metal containers) and 41 other small individual containers.

As discussed in Chapter 2, the alternatives for inorganic residues include one technology under the No Action Alternative, two technologies under the Process without Plutonium Separation Alternative, two technologies under the Process with Plutonium Separation Alternative, and one technology under Alternative 4. The preferred processing technology is to repackage the inorganic residues at Rocky Flats with a variance.

This section presents the environmental impacts of managing the entire inventory of inorganic residues under each of the six technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.10.1 Products and Wastes

Every processing technology for inorganic residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues, containing plutonium in excess of the safeguards termination limits. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then these stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone would be generated only at the Savannah River Site if the residues are shipped to that site for plutonium separation. The final form for the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a by-product of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults.

Table 4–44 Risks Due to Accidents with Graphite Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Repackage and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	4.6×10^{-7}	0.0080	4.3×10^{-6}
	Composite	4.7×10^{-7}	0.0082	4.4×10^{-6}
Alternative 2 (without Plutonium Separation)				
Cement at Rocky Flats	Earthquake (Bldg. 371)	1.5×10^{-8}	0.00018	9.3×10^{-8}
	Composite (Bldg. 371)	2.3×10^{-8}	0.00027	1.4×10^{-7}
	Earthquake (Bldg. 707) [b]	2.8×10^{-7}	0.0049	2.6×10^{-6}
	Composite (Bldg. 707) [b]	2.9×10^{-7}	0.0051	2.7×10^{-6}
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	2.7×10^{-7}	0.0048	2.6×10^{-6}
	Composite	2.8×10^{-7}	0.0050	2.7×10^{-6}
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	4.6×10^{-7}	0.0080	4.3×10^{-6}
	Composite (Bldg. 707)	4.7×10^{-7}	0.0082	4.4×10^{-6}
	Earthquake (Bldg. 371) [c]	2.5×10^{-8}	0.00029	1.5×10^{-7}
	Composite (Bldg. 371) [c]	3.6×10^{-8}	0.00042	2.2×10^{-7}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Earthquake (Bldg. 371) [d]	2.5×10^{-8}	0.00029	1.5×10^{-7}
	Composite	4.9×10^{-8}	0.00054	2.3×10^{-7}
	Earthquake (Bldg. 707A) [e]	2.3×10^{-8}	0.0048	3.2×10^{-6}
	Composite	2.4×10^{-8}	0.0049	3.3×10^{-6}
Preprocess at Rocky Flats	Earthquake (Bldg. 371)	2.6×10^{-8}	0.00030	1.6×10^{-7}
	Composite	3.7×10^{-8}	0.00043	2.3×10^{-7}
Transport to Savannah River Site	Traffic Fatality	N/A	0.0016 [f]	N/A
	Radioactive Release	N/A	2.1×10^{-7}	N/A
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon) [g]	1.6×10^{-9}	0.000073	8.3×10^{-7}
	Composite [g]	3.1×10^{-9}	0.00015	8.4×10^{-7}
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**4.6×10^{-7}**	**0.0080**	**4.3×10^{-6}**
	Composite	**4.7×10^{-7}**	**0.0082**	**4.4×10^{-6}**

N/A= not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 707 is designated as an alternate location for the Cement process at Rocky Flats.

[c] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[d] Mediated electrochemical oxidation process in Building 371.

[e] Final calcination process in Building 707A.

[f] The risk is due to the mechanical impact of the accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

[g] The H-Canyon operates 100 percent of the time and the HB-Line operates 60 percent of the time.

Note: The risks due to the preferred processing technology are presented in bold type.

If plutonium is separated at Rocky Flats or the Savannah River Site, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. Any plutonium separated at Rocky Flats would also contain americium, while at the Savannah River Site the americium would go into the high-level waste.

The solid plutonium-bearing products and wastes that would be generated from inorganic residues under each of the technologies are presented in **Table 4–45**. The shaded areas of Table 4–45 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (485 drums) would be generated in the mediated electrochemical oxidation technology at Rocky Flats. This amount is much higher than the other technologies, which would generate no more than 120 drums of transuranic waste. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate over 140 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantity of low-level waste would also be highest under the mediated electrochemical oxidation technology at Rocky Flats, and much lower under all the other technologies. The quantities of high-level waste and saltstone would be low under the Purex processing technology at the Savannah River Site, and the site would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated is 18 kg (40 lb).

4.10.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of inorganic residues. These impacts are presented for incident-free operation and postulated accident scenarios. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship the inorganic residues to the Savannah River Site for mediated electrochemical oxidation/Purex processing, then four shipments would be required and the total round-trip shipping distance would be 20,900 km (13,000 mi).

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.10.2.1 Incident-Free Operations

Radiological Impacts—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–46**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of inorganic residues. The length of time necessary to process the inorganic residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

Table 4–45 Products and Wastes from Inorganic Residues

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)*[c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
Alternative 1 (No Action)						
Repackage and Store at Rocky Flats	106	37			94	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		119			40	
Blend Down at Rocky Flats		120			40	
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats		485		17	1,075	
Preprocess at Rocky Flats Mediated Electrochemical Oxidation/Purex at the Savannah River Site		14 10	– 1	– 18	40 12	– 19
Alternative 4 (Combination)						
Repackage at Rocky Flats	**106**[d]	**37**			**94**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes:

Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technology are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

Table 4–46 Radiological Impacts Due to Incident-Free Management of Inorganic Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem/year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Cancer Fatalities*
Alternative 1 (No Action)								
Repackage and Store at Rocky Flats	N/E	–	N/E	–	2,000	0.0008	4.7	0.0019
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	8.4×10^{-7}	4.2×10^{-13}	0.000034	1.7×10^{-8}	2,000	0.0008	3.8	0.0015
Blend Down at Rocky Flats	2.5×10^{-6}	1.2×10^{-12}	0.000052	2.6×10^{-8}	2,000	0.0008	4.8	0.0019
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	6.3×10^{-6}	3.2×10^{-12}	0.00013	6.5×10^{-8}	2,000	0.0008	7.4	0.0030
Preprocess at Rocky Flats	1.3×10^{-6}	6.5×10^{-13}	0.000027	1.4×10^{-8}	2,000	0.0008	3.5	0.0014
Transport to Savannah River Site	11	5.5×10^{-6}	0.39	0.0002	100	0.00004	0.62	0.00025
Mediated Electrochemical Oxidation/Purex at Savannah River Site[a]	0.000021	1.0×10^{-11}	0.0023	1.2×10^{-6}	2,000	0.0008	4.5	0.0018
Alternative 4 (Combination)								
Repackage at Rocky Flats	**N/E**	**–**	**N/E**	**–**	**2,000**	**0.0008**	**3.3**	**0.0013**

N/E = no emissions—therefore, there are no radiological impacts to the public

[a] Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

Note: The impacts due to the preferred processing technology are presented in bold type.

The highest estimated public maximally exposed individual dose in Table 4–46 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–46 would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site. The sum of these doses is 0.39 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

The highest involved worker population radiation dose would be approximately 8.6 person-rem, which would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site. This dose would cause 0.0035 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be much smaller than the impacts to the involved workers.

Hazardous Chemical Impacts—The processing of inorganic residues at Rocky Flats would not involve airborne releases of hazardous chemicals. No carcinogenic chemicals are released from the mediated electrochemical oxidation process at the Savannah River Site. Noncancer health risks resulting from releases of phosphoric acid and ammonium nitrate are low; the Hazard Index values presented in **Table 4–47** are much less than one. The impacts due to the preferred processing technology are presented in bold type.

4.10.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with inorganic residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–48**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

Table 4–47 Chemical Impacts Due to Incident-Free Management of Inorganic Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities*[a]	*Probability of Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities*[a]
Alternative 1 (No Action)						
Repackage and Store at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Blend Down at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Preprocess at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00005[c]	N/A	N/A	(c)
Mediated Electrochemical Oxidation/Purex at Savannah River Site[d, e]	N/E	2×10^{-9}	N/E	N/E	2×10^{-8}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**

N/E = no emissions N/A = not applicable—the maximally exposed individual is undefined for vehicle emissions

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively. However, the risk to the public dominates. See Appendix E, Section E.4 for additional information.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–48 Accident Frequencies, Process Durations, and Consequences for Accidents with Inorganic Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer or Traffic Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Alternative 1 (No Action)									
Repackage and Store at Rocky Flats [a]	Explosion (Bldg. 707) [b]	0.00005	0.043	960	0.00048	16,800	8.4	11,200	0.0045
	Earthquake (Bldg. 707) [c]	0.0026	0.043	562	0.00028	9,830	4.9	6,550	0.0026
Alternative 2 (without Plutonium Separation)									
Vitrify at Rocky Flats	Explosion (Bldg. 707) [b]	0.00005	0.043	960	0.00048	16,800	8.4	11,200	0.0045
	Earthquake (Bldg. 707) [c]	0.0026	0.043	337	0.00017	5,900	3.0	3,930	0.0016
Blend Down at Rocky Flats	Explosion (Bldg. 707) [b]	0.00005	0.043	960	0.00048	16,800	8.4	11,200	0.0045
	Earthquake (Bldg. 707) [c]	0.0026	0.043	562	0.00028	9,830	4.9	6,550	0.0026
	Earthquake (Bldg. 371) [b, d]	0.000094	0.043	843	0.00042	9,830	4.9	6,550	0.0026
	Room Fire (Bldg. 371) [c, d]	0.0005	0.043	173	0.000087	2,020	1.0	1,350	0.00054
Alternative 3 (with Plutonium Separation)									
Mediated Electrochemical Oxidation at Rocky Flats	Criticality (Bldg. 371) [e]	0.0001	0.063	790	0.00040	6,980	3.5	321	0.00013
	Explosion (Bldg. 707A) [b, f]	0.00005	0.058	236	0.00012	4,920	2.5	4,130	0.0017
	Earthquake (Bldg. 707A) [c, f]	0.0026	0.058	207	0.00010	4,310	2.2	3,620	0.0015
Preprocess at Rocky Flats	Earthquake (Bldg. 371) [b]	0.000094	0.051	698	0.00035	8,140	4.1	5,430	0.0022
	Room Fire (Bldg. 371) [c]	0.0005	0.051	143	0.000072	1,670	0.84	1,110	0.00044
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	4 shipments	N/A	N/A	N/A	1.0 [g]	N/A	(h)
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon) [i]	0.000182	0.42	65	0.000033	2,930	1.5	20,800	0.017
Alternative 4 (Combination)									
Repackage at Rocky Flats	**Explosion (Bldg. 707) [b]**	**0.00005**	**0.043**	**960**	**0.00048**	**16,800**	**8.4**	**11,200**	**0.0045**
	Earthquake (Bldg. 707) [c]	**0.0026**	**0.043**	**562**	**0.00028**	**9,830**	**4.9**	**6,550**	**0.0026**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Highest consequence accident for this processing technology.

[c] Highest risk accident for this processing technology.

[d] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[e] Mediated electrochemical oxidation process in Building 371.

[f] Final calcination process in Building 707A.

[g] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list in a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[h] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

[i] HB-Line operates 60 percent of the time. Dose estimates assumed the HB-Line was operating at the time of the accident.

Note: The impacts due to the preferred processing technology are presented in bold type.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–48 for each of the six inorganic residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequences to all three receptors would occur if DOE decides to implement either the repackage (under Alternative 1 or 4), the vitrification, or the blend down technology and an explosion occurs in Building 707 during the 0.043 years of residue processing at Rocky Flats.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–49** for each of the five inorganic residue processing technologies. The risk due to the highest risk accident and a composite risk associated with all major accidents are both presented. The risks due to the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 3.1×10^{-8}, which is due to an earthquake during processing of the residue with the repackage or the blend down technology in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten million. The highest risk to the public population is estimated to be 0.00055 latent cancer fatalities, which is also due to an earthquake during processing of the residue with the repackage or the blend down technology in Building 707. The highest risk to the individual noninvolved onsite worker is estimated to be 8.3×10^{-7}, which is due to an earthquake during processing of the residue with the mediated electrochemical oxidation technology in the Savannah River Site H-Canyon. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million.

4.11 IMPACTS OF MANAGING SCRUB ALLOY

The inventory of scrub alloy weighs approximately 700 kg (1,540 lb), including approximately 200 kg (440 lb) of plutonium. The entire inventory is stored in 42 packages in shipping containers, 57 packages ready to be loaded into shipping containers, and 177 small individual containers.

As discussed in Chapter 2, the alternatives for scrub alloy include one technology under the No Action Alternative, one technology under the Process without Plutonium Separation Alternative, and one technology under the Process with Plutonium Separation Alternative. There is no processing technology under Alternative 4. The preferred processing technology is to repackage the scrub alloy at Rocky Flats and to use Purex at the Savannah River Site.

This section presents the environmental impacts of managing the entire inventory of scrub alloy under each of the three technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

Table 4–49 Risks Due to Accidents with Inorganic Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Repackage and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	3.1×10^{-8}	0.00055	2.9×10^{-7}
	Composite	3.4×10^{-8}	0.00059	3.1×10^{-7}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.9×10^{-8}	0.00033	1.8×10^{-7}
	Composite	2.1×10^{-8}	0.00036	1.9×10^{-7}
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	3.1×10^{-8}	0.00055	2.9×10^{-7}
	Composite (Bldg. 707)	3.4×10^{-8}	0.00059	3.1×10^{-7}
	Room Fire (Bldg. 371) [b]	1.9×10^{-9}	0.000022	1.2×10^{-8}
	Composite (Bldg. 371) [b]	3.6×10^{-9}	0.000042	2.2×10^{-8}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Criticality (Bldg. 371) [c]	2.5×10^{-9}	0.000022	8.1×10^{-10}
	Composite	6.0×10^{-9}	0.000063	2.3×10^{-8}
	Earthquake (Bldg. 707A) [d]	1.6×10^{-8}	0.00032	2.2×10^{-7}
	Composite	1.7×10^{-8}	0.00035	2.3×10^{-7}
Preprocess at Rocky Flats	Room Fire (Bldg. 371)	1.8×10^{-9}	0.000021	1.1×10^{-8}
	Composite	3.5×10^{-9}	0.000041	2.2×10^{-8}
Transport to Savannah River Site	Traffic Fatality	N/A	0.0004 [e]	N/A
	Radioactive Release	N/A	4.0×10^{-8}	N/A
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon) [f]	1.6×10^{-9}	0.000073	8.3×10^{-7}
	Composite [f]	3.1×10^{-9}	0.00015	8.4×10^{-7}
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	$\mathbf{3.1\times10^{-8}}$	**0.00055**	$\mathbf{2.9\times10^{-7}}$
	Composite	$\mathbf{3.4\times10^{-8}}$	**0.00059**	$\mathbf{3.1\times10^{-7}}$

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[c] Mediated electrochemical oxidation process in Building 371.

[d] Final calcination process in Building 707A.

[e] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

[f] The H-Canyon operates 100 percent of the time and the HB-Line operates 60 percent of the time.

Note: The risks due to the preferred processing technology are presented in bold type.

4.11.1 Products and Wastes

Every processing technology for scrub alloy would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate repackaged scrub alloy that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In one of the processing technologies the repackaged scrub alloy and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2.

High-level waste and saltstone would be generated only at the Savannah River Site if the scrub alloy were shipped to that site for plutonium separation. The final form for the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a byproduct of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults. If plutonium is separated at the Savannah River Site, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes.

The solid plutonium-bearing products and wastes that would be generated from scrub alloy under each of the technologies are presented in **Table 4–50**. The shaded areas of Table 4–50 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (2,809 drums) would be generated in the calcine and vitrify technology. Most of this amount would be generated directly from processing the scrub alloy. Transuranic waste that is derived directly from scrub alloy was not included in the Rocky Flats inventory in the WIPP Supplemental EIS, so additional analysis would be required before most of these 2,809 drums of transuranic waste could be disposed of in WIPP (see Section 2.4.10.2). Furthermore, this amount is much higher than the other technolgies, which would generate no more than 61 drums of transuranic waste. The quantities of high-level waste, low-level waste, and saltstone would be low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated is 200 kg (440 lb).

4.11.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the alternatives associated with the management of scrub alloy. These impacts are presented for incident-free operation and postulated accident scenarios. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship the scrub alloy to the Savannah River Site for Purex processing, then six shipments would be required and the total round-trip shipping distance would be 31,400 km (19,500 mi).

Table 4–50 Products and Wastes from Scrub Alloy

	Repackaged Scrub Alloy (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)*[c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
Alternative 1 (No Action)						
Repackage and Store at Rocky Flats	276	59			140	
Alternative 2 (without Plutonium Separation)						
Calcine and Vitrify at Rocky Flats		2,809			140	
Alternative 3 (with Plutonium Separation)						
Repackage at Rocky Flats		**38**	**–**	**–**	**85**	**–**
Purex at Savannah River Site		**23**	**0.3**	**200**	**82**	**103**

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technology are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.11.2.1 Incident-Free Operations

Radiological Impacts—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–51**. The impacts due to the preferred technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of scrub alloy. The length of time necessary to process the scrub alloy will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized scrub alloy, separated plutonium, and wastes would be much smaller than from processing or transportation.

The highest estimated public maximally exposed individual dose in Table 4–51 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–51 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is 0.62 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose

The highest involved worker population radiation dose would be approximately 142 person-rem, which would occur if DOE decides to implement the calcine and vitrify technology at Rocky Flats. This dose would cause 0.057 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the scrub alloy are designated as "noninvolved workers." The impacts to these workers would be much smaller than the impacts to the involved workers.

Hazardous Chemical Impacts—The processing of scrub alloy at Rocky Flats would not involve airborne releases of hazardous chemicals. No carcinogenic chemicals would be released from the Purex process at the Savannah River Site. Noncancer health risks resulting from the release of phosphoric acid and ammonium nitrate are low; the Hazard Index values presented in **Table 4–52** are much less than one. The impacts due to the preferred processing technology are presented in bold type.

4.11.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with scrub alloy are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate for the purpose of comparing processing technologies

against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

Table 4–51 Radiological Impacts Due to Incident-Free Management of Scrub Alloy

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem/yr)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Alternative 1 (No Action)								
Repackage and Store at Rocky Flats	0.000042	2.1×10^{-11}	0.0017	8.5×10^{-7}	2,000	0.0008	35	0.014
Alternative 2 (without Plutonium Separation)								
Calcine and Vitrify at Rocky Flats	0.000063	3.2×10^{-11}	0.0025	1.2×10^{-6}	2,000	0.0008	142	0.057
Alternative 3 (with Plutonium Separation)								
Repackage at Rocky Flats	**0.000066**	**3.3×10^{-11}**	**0.0014**	**7.0×10^{-7}**	**2,000**	**0.0008**	**34**	**0.014**
Transport to Savannah River Site	**11**	**5.5×10^{-6}**	**0.59**	**0.00030**	**100**	**0.00004**	**0.93**	**0.0004**
Purex at Savannah River Site[a]	**0.00024**	**1.2×10^{-10}**	**0.0255**	**0.000013**	**2,000**	**0.0008**	**25**	**0.010**

[a] Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–52 Chemical Impacts Due to Incident-Free Management of Scrub Alloy

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of a Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities*[a]	*Probability of a Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities*[a]
Alternative 1 (No Action)						
Repackage and Store at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Calcine and Vitrify at Rocky Flats[b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Repackage at Rocky Flats[b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Transport to Savannah River Site	**N/A**	**N/A**	**0.00008[c]**	**N/A**	**N/A**	**(c)**
Purex at Savannah River Site[d, e]	**N/E**	**2×10^{-9}**	**N/E**	**N/E**	**2×10^{-8}**	**N/E**

N/E = no emissions N/A = not applicable—the maximally exposed individual is undefined for vehicle emissions

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively. However, the risk to the public dominates. See Appendix E, Section E.4 for additional information.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The impacts due to the preferred processing technology are presented in bold type.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–53**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–53, for each of the three scrub alloy processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequences to all three receptors would occur if DOE decides to implement the Purex technology at the Savannah River Site and a major earthquake strong enough to cause a breach in the H-Canyon during the 0.50 years of scrub alloy processing at the Savannah River Site.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–54** for each of the three scrub alloy processing technologies. The risk associated with the highest risk accident and a composite risk due to all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 2.0×10^{-8}, which is due to an earthquake during repackaging of the scrub alloy at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten million. The highest risk to the public population is estimated to be 0.00082 latent cancer fatalities, which is due to an earthquake during processing of the scrub alloy with the Purex technology at the Savannah River Site. The highest risk to the individual noninvolved onsite worker is estimated to be 9.9×10^{-6}, and is due to the same accident scenario at the Savannah River Site. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

4.12 AIR QUALITY

The potential human health impacts of hazardous chemicals (carbon tetrachloride, phosphoric acid, hydrochloric acid, and ammonium nitrate) are evaluated in the hazardous chemical impacts subsections for each material category (Sections 4.2-4.11). In addition to hazardous chemicals, some of the processing technologies could release criteria and other regulated air pollutants. These chemical and air pollutant concentrations are compared in this section to the corresponding Federal and State air pollution standards or guidelines. Radiological air emissions are discussed and compared to the National Emission Standards for Hazardous Air Pollutants in the Cumulative Impact Section (4.25).

Table 4–53 Accident Frequencies, Process Durations, and Consequences for Accidents with Scrub Alloy

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer or Traffic Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Alternative 1 (No Action)									
Repackage and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	0.11	142	0.000071	2,640	1.3	1,730	0.00069
Alternative 2 (without Plutonium Separation)									
Calcine and Vitrify at Rocky Flats	Earthquake (Bldg. 707) [b]	0.0026	2.21	4.3	2.2×10^{-6}	79	0.040	52	0.000021
	Dock Fire (Bldg. 707) [c]	2.0×10^{-6}	2.21	25	0.000013	468	0.23	306	0.00012
Alternative 3 (with Plutonium Separation)									
Repackage at Rocky Flats	**Earthquake (Bldg. 371) [c]**	**0.000094**	**0.12**	**131**	**0.000066**	**1,550**	**0.78**	**1,010**	**0.00040**
	Room Fire (Bldg. 371) [b]	**0.0005**	**0.12**	**27**	**0.000014**	**318**	**0.16**	**208**	**0.000083**
Transport to Savannah River Site	**Traffic Fatality**	**0.00010 per shipment**	**6 shipments**	**N/A**	**N/A**	**N/A**	**1.0 [d]**	**N/A**	**e**
Purex at Savannah River Site	**Earthquake (H-Canyon)**	**0.000182**	**0.50**	**407**	**0.00020**	**18,100**	**9.1**	**136,000**	**0.11**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Highest risk accident for this processing technology.

[c] Highest consequence accident for this processing technology.

[d] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list in a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[e] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–54 Risks Due to Accidents with Scrub Alloy

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Repackage and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	2.0×10^{-8}	0.00038	2.0×10^{-7}
	Composite	2.1×10^{-8}	0.00039	2.1×10^{-7}
Alternative 2 (without Plutonium Separation)				
Calcine and Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.2×10^{-8}	0.00023	1.2×10^{-7}
	Composite	1.3×10^{-8}	0.00024	1.3×10^{-7}
Alternative 3 (with Plutonium Separation)				
Preprocess at Rocky Flats	**Room Fire (Bldg. 371)**	**8.1×10^{-10}**	**9.6×10^{-6}**	**5.0×10^{-9}**
	Composite	**1.6×10^{-9}**	**0.000018**	**9.6×10^{-9}**
Transport to Savannah River Site	**Traffic Fatality**	**N/A**	**0.0006 [b]**	**N/A**
	Radioactive Release	**N/A**	**4.3×10^{-8}**	**N/A**
Purex at Savannah River Site	**Earthquake (H-Canyon)**	**1.9×10^{-8}**	**0.00082**	**9.9×10^{-6}**
	Composite	**2.9×10^{-8}**	**0.0013**	**9.9×10^{-6}**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

Note: The risks due to the preferred processing technology are presented in bold type.

Tables 4–55 (Rocky Flats) and **4–56** (Savannah River Site) present the sites' existing modeled concentrations of criteria and hazardous air pollutants and the modeled concentrations associated with the proposed processing at each site and compares them to existing Federal and State air quality standards and guidelines. The Industrial Source Complex air dispersion model ISC3 was used to develop these estimates (see Appendix D, Section D.4). The types of air pollutants differ by site because of differences in the chemical constituents of the residue materials and in the chemical reactants required for the various processes. These modeled concentrations represent the maximum predicted releases at each site from processing residues and scrub alloy. The impacts from each residue and scrub alloy processing technology have been combined and assumed to occur concurrently at each site. This is a very conservative assumption made because nonradiological air emissions and corresponding concentrations associated with the various processing alternatives are small and are not considered by DOE to be a discriminator between alternatives.

For Rocky Flats, nitrogen oxide (NO_x) is the only criteria pollutant expected to be released. Concentrations of this pollutant are compared to the annual standard for nitrogen dioxide (NO_2). In addition, concentrations of the hazardous air pollutants carbon tetrachloride and hydrochloric acid at Rocky Flats are presented. There are no Federal or State guidelines or standards for these hazardous pollutants. Consequently, these concentrations are compared to EPA established cancer inhalation unit risk factors (for carbon tetrachloride) and Reference Concentrations (for hydrochloric acid) in the health effects of hazardous chemicals subsections of this chapter. When the contribution from the alternatives is combined with the concentrations from existing facilities at Rocky Flats, the concentrations are well below the standards and guidelines.

Ambient air concentrations based on monitoring data and modeled data from nearby non-DOE sources are discussed in Section 3.1.3. If these ambient air concentrations are combined with the concentrations in Table 4-55, the resulting concentrations would also be well below the air quality standards and guidelines. Note that combining the site's concentrations with the ambient concentrations is very conservative, as it is expected that the monitors would be impacted by Rocky Flats emission sources in addition to non-DOE sources.

For the Savannah River Site, nitrogen oxide concentrations are compared to the annual standard for nitrogen dioxide. No other criteria pollutants are expected to be emitted. In addition, concentrations of total suspended particulates, nitric acid, hydrogen fluoride, and phosphoric acid at the Savannah River Site are compared to the State standards. The modeled concentrations are very small. When these concentrations are combined with the concentrations from existing facilities at the Savannah River Site the concentrations are well below the standards and guidelines.

Ambient air concentrations based on monitoring data are discussed in Section 3.2.3. If these ambient air concentrations are combined with the concentrations in Table 4-56, the resulting concentrations would be below the air quality standards and guidelines, except for the State's annual total suspended particulates standard of 75 $\mu g/m^3$. The combined annual total suspended particulates concentration would be 80 $\mu g/m^3$. Note that combining the site's concentrations with the ambient concentrations is very conservative, as it is expected that the monitors would be impacted by Savannah River Site emission sources as well as any non-DOE sources. In addition, the State air quality agency does not require the site to add monitored concentrations to modeled concentrations for demonstrating compliance with the air quality standards (SRS 1998).

The Los Alamos National Laboratory is not included in the table because no hazardous chemicals and only a very small quantity of criteria air pollutants would be released to the atmosphere due to the very limited processing that would take place at that site under any of the processing technologies. Air pollutant emissions and concentrations will be unchanged and are expected to continue to meet the ambient standards.

Table 4–55 Air Quality Impacts from Process Emissions at Rocky Flats

Pollutant	*Averaging Time*	*Most Stringent Regulation or Guideline (µg/m³)[a]*	*Site Baseline Concentration (µg/m³)[b]*	*Modeled Concentration[h] (µg/m³)*	*Combined Concentration from Rocky Flats Sources (µg/m³)*	*Percent of Standard or Guideline*
Criteria Pollutants						
CO	8-Hour	10,000[c]	304	0	304	3.0
	1-Hour	40,000[c]	1,160	0	1,160	2.9
NO_2	Annual	100[c]	1.4	0.00014	1.4	1.4
Ozone	8-Hour	157[c,e]	(e)	(e)	(e)	NC
	1-Hour	160[d,e]	(e)	(e)	(e)	NC
PM_{10}	Annual	50[c,f]	14.0	0	14.0	28
	24-Hour	150[c,f]	32.0	0	32.0	21
$PM_{2.5}$	Annual	15[c,f]	(f)	(f)	(f)	NC
	24-Hour	65[c,f]	(f)	(f)	(f)	NC
SO_2	Annual	80[c]	0.1	0	0.1	0.13
	24-Hour	365[c]	91.2	0	91.2	25
	3-Hour	700[d]	270	0	270	39
Lead	Calendar Quarter	1.5[c]	< 0.001	0	<0.001	<0.1
	30-Day	1.5[d]	< 0.001	0	<0.001	<0.1
Other Regulated Pollutants						
Hydrogen Sulfide	1-Hour	142[d]	35.4	0	35.4	25
Total Suspended Particulates	Annual	75[d]	31.0	0	31.0	41
	24-Hour	150[d]	73.0	0	73.0	49
Toxic/Hazardous Pollutants						
Carbon Tetrachloride	Annual	(g)	0.0024	0.000031	0.0024	NC
Hydrochloric Acid	Annual	(g)	0.0052	4.2×10^{-7}	0.0052	NC

NC = not calculated

Note: Only toxic pollutants emitted from the alternatives being evaluated are presented. The Draft EIS listed additional toxic pollutants which would not be emitted from any of the proposed alternatives and so are not necessary to assess baseline or cumulative air quality impacts.

[a] The more stringent of the Federal and State standards is presented.

[b] Concentrations based on Rocky Flats Cumulative Impacts Document, 1997. Monthly lead concentration conservatively used to estimate quarterly concentration.

[c] Federal standard.

[d] State standard.

[e] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. EPA recently revised the air quality standards for ozone. The new standards, finalized on July 18, 1997, change the ozone primary and secondary standards from a 1-hour concentration of 235 µg/m³ (0.12 ppm) to an 8-hour concentration of 157 µg/m³ (0.08 ppm). During a transition period, the 1-hour ozone standard would continue to apply in nonattainment areas such as Rocky Flats.

[f] EPA recently revised the air quality standards for particulate matter. The current PM_{10} annual standard is retained and two $PM_{2.5}$ (particulate matter less than or equal to 2.5 micrometers) standards are added. The standards are set at 15 µg/m³ (3-year arithmetic mean based on community-oriented monitors) and 65 µg/m³ (3-year average of the 98th percentile of 24-hour concentrations at population-oriented monitors). The current 24-hour PM_{10} standard is revised to be based on the 99th percentile of 24-hour concentrations. Insufficient emissions, modeling and monitoring data exist for estimating concentrations of $PM_{2.5}$.

[g] No State or Federal standard exists.

[h] Based on emissions from combining all processing technologies for residues and scrub alloy.

Source: Adapted from DOE 1996a

Table 4–56 Air Quality Impacts from Process Emissions at Savannah River Site

Pollutant	*Averaging Time*	*Most Stringent Regulation or Guideline ($\mu g/m^3$)[a]*	*Site Baseline Concentration ($\mu g/m^3$)[b]*	*Modeled Concentration[h] ($\mu g/m^3$)*	*Combined Concentration from Savannah River Sources ($\mu g/m^3$)*	*Percent of Standard or Guideline*
Criteria Pollutants						
CO	8-Hour	10,000[c]	632	0	632	6.3
	1-Hour	40,000[c]	5,000	0	5,000	13
NO_2	Annual	100[c]	8.8	0.039	8.8	8.8
Ozone	8-Hour	157[c,f]	(f)	(f)	(f)	NC
PM_{10}	Annual	50[c,d]	4.8	0	4.8	9.6
	24-Hour	150[c,d]	80.6	0	80.6	54
$PM_{2.5}$	Annual	15[c,d]	(d)	(d)	(d)	NC
	24-Hour	65[c,d]	(d)	(d)	(d)	NC
SO_2	Annual	80[c]	16.3	0	16.3	20
	24-hour	365[c]	215	0	215	59
	3-Hour	1,300[c]	690	0	690	53
Lead	Calendar Quarter	1.5[c]	<0.01	0	<0.01	<0.1
Other Regulated Pollutants						
Hydrogen Fluoride	30-Day	0.8[e]	0.09	0.00036	0.09	11
	7-Day	1.6[e]	0.39	0.0032[g]	0.39	25
	24-Hour	2.9[e]	1.04	0.0032	1.04	36
	12-Hour	3.7[e]	1.99	0.0051	2.00	54
Total Suspended Particulates	Annual	75[e]	43.3	0	43.3	58
Toxic/Hazardous Pollutants						
Nitric Acid	24-Hour	125.0[e]	50.96	0.65	51.61	41
Phosphoric Acid	24-Hour	25.0[e]	0.462	0.0016	0.464	1.9

NC = not calculated

Note: Only toxic pollutants emitted from the alternatives being evaluated are presented. The Draft EIS listed additional toxic pollutants which would not be emitted from any of the proposed alternatives and so are not necessary to assess baseline or cumulative air quality impacts.

[a] The more stringent of the Federal and State standards is presented.

[b] Concentration based on *Draft Tritium Extraction Facility EIS*, (DOE 1998a) (1994 emissions data), except for hydrogen fluoride, nitric acid, and phosphoric acid which are based on *Storage and Disposition of Weapons - Usable Fissile Materials Final PEIS*, (DOE 1996a) (1990 emissions data).

[c] Federal standard.

[d] EPA recently revised the air quality standards for particulate matter. The current PM_{10} annual standard is retained and two $PM_{2.5}$ (particulate matter less than or equal to 2.5 micrometers) standards are added. The standards are set at 15 $\mu g/m^3$ (3-year arithmetic mean based on community-oriented monitors) and 65 $\mu g/m^3$ (3-year average of the 98th percentile of 24-hour concentrations at population-oriented monitors). The current 24-hour PM_{10} standard is revised to be based on the 99th percentile of 24-hour concentrations. Insufficient emissions, modeling and monitoring data exist for estimating concentrations of $PM_{2.5}$.

[e] State standard.

[f] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. EPA recently revised the air quality standards for ozone. The new standards, finalized on July 18, 1997, change the ozone primary and secondary standards from a 1-hour concentration of 235 $\mu g/m^3$ (0.12 ppm) to an 8-hour concentration of 157 $\mu g/m^3$ (0.08 ppm).

[g] 7-day concentration conservatively estimated using 24-hour concentration.

[h] Based on emissions from combining all processing technologies for residues and scrub alloy.

Source: Adapted from DOE 1998a and DOE 1996a.

In addition to the releases of criteria pollutants from processing facilities, the shipment of residues and scrub alloy between sites would also contribute to the emissions of criteria pollutants. The impacts of these mobile sources of pollutants on air quality would be very low. See the Cumulative Impacts discussion in Section 4.25.4 for additional information.

The increase in NO_2 annual average concentrations from processing at Rocky Flats and Savannah River Site are a small fraction of the Prevention of Significant Deterioration Class II area increment of 25 $\mu g/m^3$. Any contribution to NO_2 concentrations at a Class I area, such as Rocky Mountain National Park near Rocky Flats, would be a very small fraction of the Prevention of Significant Deterioration Class I increment of 2.5 $\mu g/m^3$. None of these alternatives have emissions large enough to require a Prevention of Significant Deterioration permit.

The EPA has established National Ambient Air Quality Standards throughout the U.S. for the six criteria pollutants, and each State is responsible for measuring its air quality to determine if and when the air fails to meet these standards. Each State also has a State Implementation Plan to eliminate or reduce the severity and number of violations of the National Ambient Air Quality Standards. Areas with a history of violations are called "nonattainment areas". Federal actions, such as the actions described in this EIS, must conform to each State's State Implementation Plan to avoid contributing to a violation of the National Ambient Air Quality Standards (EPA 1993). If a proposed Federal action would 1) occur in a "nonattainment area" and 2) could release significant quantities of criteria pollutants, then the Federal agency is required to perform a conformity analysis to determine if the proposed Federal action would conform to the State Implementation Plan.

The National Ambient Air Quality Standards attainment status of the areas around the Savannah River Site and the Los Alamos National Laboratory are discussed in Sections 3.2.3 and 3.3.3, respectively. These sites are not located in "nonattainment areas", so no conformity analysis is required for these sites in this EIS.

As discussed in Section 3.1.3, however, Rocky Flats is located in a "nonattainment area" for ozone (O_3) and carbon monoxide (CO). Ozone itself is not emitted from Rocky Flats, but is formed in the atmosphere through a complex reaction of ozone precursor pollutants, sunlight, and temperature. Two ozone precursors could be emitted from Rocky Flats: nitrogen dioxide (NO_2) and volatile organic chemicals. DOE considered the quantities of NO_2, volatile organic chemicals, and CO that could be released at Rocky Flats due to the actions in this EIS. Total direct and indirect emissions, including transportation emissions, have been estimated based on the process descriptions at Rocky Flats and the maximum number of shipments from Rocky Flats. The number of shipments along with EPA's MOBILE 5 model was used to estimate exhaust emissions from the safe, secure trailers and escort vehicles traveling through the "nonattainment area." The total estimated emissions are 89 kg/yr (196 lb/yr) of NO_2, 17 kg/yr (37 lb/yr) of VOCs, and 56 kg/yr (123 lb/yr) of CO and are mainly due to transportation. These emission levels are all far below the applicability level which would trigger a conformity analysis (90,000 kg/yr [200,000 lb/yr] for each of these chemicals) (40 CFR 51; 40 CFR 93). Furthermore, these estimated emissions would be much smaller than the normal emissions from vehicles in the Denver area. Thus, DOE did not perform a conformity analysis for O_3 or CO in the Rocky Flats area.

Rocky Flats is also in a "nonattainment area" for particulate matter of 10 microns or smaller in diameter (PM_{10}). Transportation is the only action in this EIS that would be expected to generate PM_{10}, from reentrainment of road dust and from diesel-powered truck exhaust. The maximum number of shipments involved in this EIS, however, is tiny compared to the amount of transportation that occurs normally in the Denver area, so the PM_{10} emissions attributable to this EIS, 102 kg/yr (225 lb/yr), would be a small fraction of the total emissions in the Denver area. The PM_{10} emissions were estimated using shipment information along

with EPA's PART 5 model. Thus, DOE did not perform a conformity analysis for PM_{10} in the Rocky Flats area.

4.13 WATER QUALITY

None of the processing technologies at any of the sites would discharge untreated process effluents to surface water or ground water. Effluents would be processed at existing site facilities as follows:

- All process effluents produced from Rocky Flats processes are either directly stabilized for disposal or reused in the process water system (a closed-cycle system).

- All process effluents produced from Savannah River Site processes (in the F-Canyon or H-Canyon) would be pumped directly to the High-Level Waste system for treatment and disposal of residuals or to the Z-Area Saltstone Treatment and Disposal Facility.

- All process effluents produced from Los Alamos National Laboratory processes would be transferred to the Radioactive Liquid Waste Treatment Facility for treatment.

Any water released from the above treatment processes to the surface or groundwater would meet the applicable water quality requirements of the State. Thus, there would be no impact on water quality at any of the three sites under incident-free conditions.

The sections below provide additional detail on the specific types and amounts of effluents that would result from the processing technologies at the three sites and the treatments for those effluents prior to any water being discharged to the surface or groundwater.

Analyses have been performed on the impacts of accidents on water pathways. Using a bounding case analysis, DOE considered the worst accidents (identified in Appendix D), calculated the maximum concentrations of radioactivity deposited to the ground surface, and calculated the drinking water pathway exposure for that worst accident. From this, DOE calculated the highest dose to the maximally exposed individual located at the site boundary and from drinking water from a hypothetical water supply pond.

In the event of a major earthquake or an airplane crash at a facility that is processing plutonium residues or scrub alloy, radioactive material might be released into surface waters. The amount of material that may be released from the facility to the surface water and subsequently flow offsite would be very small. Analyses have shown that for weapons grade plutonium accidents, inhalation is the only exposure of importance. Ingestion of both food and water contributes less than 0.2 percent of the total dose to the population. (EG&G 1993). A traffic accident involving a truck carrying containers of plutonium residues or scrub alloy would have no impact on water quality because the containers are all designed to contain the material, even if the containers are submerged in water after the traffic accident.

4.13.1 Rocky Flats

The materials to be processed at Rocky Flats would be processed in Buildings 707 or 371. Effluents would consist of water (some with potassium hydroxide and potassium nitrate), filtrate, and evaporator bottoms. Most of the processing technologies would not generate any effluents. The processing technologies that would generate effluents are listed in **Table 4–57**.

Table 4–57 Process Effluents at Rocky Flats

Residue Category	Processing Technology	Effluent Description
Combustible (Aqueous-contaminated)	Neutralize/Dry and Store	5,250 kg water with potassium hydroxide and potassium nitrate
Combustible	Sonic Wash	11,000 kg water
Combustible	Catalytic Chemical Oxidation	40 kg hydrochloric acid 164 kg water
Combustible	Mediated Electrochemical Oxidation	2,900 kg evaporator bottoms, with 0.1 kg Pu
Combustible (Aqueous-contaminated)	Neutralize/Dry with Variance	5,250 kg water with potassium hydroxide and potassium nitrate
Plutonium Fluoride	Dissolve, Oxidize and Store	1,960 kg filtrate
Plutonium Fluoride	Dissolve and Oxidize	1,960 kg filtrate
All Filter Media	Neutralize/Dry and Store	25,700 kg water with potassium hydroxide and potassium nitrate
All Filter Media	Sonic Wash	25,500 kg water
All Filter Media	Mediated Electrochemical Oxidation	6,800 kg evaporator bottoms, with 1.0 kg Pu
Ful Flo (IDC 331) and HEPA (IDC 338) Filters	Neutralize/Dry with Variance	24,400 kg water with potassium hydroxide and potassium nitrate
All Sludge	Filter/Dry and Store	31 kg decant water
Other Sludge	Acid Dissolve	3,700 filtrate
Other Sludge	Filter/Dry with Variance	31 kg decant water
Glass	Neutralize/Dry and Store	1,340 kg water with potassium hydroxide and potassium nitrate and with 5.0 kg Pu
Glass	Mediated Electrochemical Oxidation	370 kg evaporator bottoms, with 0.1 kg Pu
Glass	Neutralize/Dry with Variance	1,340 kg water with potassium hydroxide and potassium nitrate and with 5.0 kg Pu
Graphite	Mediated Electrochemical Oxidation	6,100 kg acid, with 0.1 kg Pu

There would be no direct discharge of contaminants to the surface or ground water for any of the Rocky Flats processing technologies in any of the alternatives. All aqueous waste produced would either be directly stabilized for disposal or reused in the process water system. All plutonium-containing waste waters generated at the site are treated by evaporation and, in some cases, preceded by an initial carrier precipitation step. The solids and concentrated solution from these treatment steps are immobilized and stored pending disposal at an approved disposal facility. The resulting treated solution must meet the State of Colorado Reuse Criteria specified in 6 CCR-1007-3, Part 261.2(e)(ii), and is recycled to the site process water system where it is used as make-up water for the site steam plant and cooling towers. Although it is largely a closed system, there are occasional process water system discharges of excess water to the site sewage treatment plant, based on overall water balance considerations. All sewage treatment plant effluent must meet National Pollution Discharge Elimination System permit requirements. Thus, none of the effluents from the waste water treatment facility are discharged to the surface or groundwater.

4.13.2 Savannah River Site

If any materials are sent to the Savannah River Site under this EIS, they would be processed through either F-Canyon or H-Canyon. Effluents would consist of various aqueous solutions. The materials, processing technologies, and effluents are presented in **Table 4–58**.

Table 4–58 Process Effluents at the Savannah River Site

Residue Category	*Processing Technology*	*Effluent Description*
Incinerator Ash	Purex	Aqueous solution containing tin, fly ash, residual plutonium and spent processing reagents
Incinerator Ash	MEO/Purex	Aqueous solution containing fly ash, residual plutonium and spent processing reagents
Sand, Slag and Crucible	Purex	Aqueous solution containing tin, calcium, magnesium, residual plutonium and spent processing reagents
Graphite Fines	MEO/Purex	Aqueous solution containing residual plutonium and spent processing reagents
All Salt Residues	Purex, after salt scrub at Rocky Flats	Aqueous solution containing americium, aluminum, residual plutonium and spent processing reagents
Plutonium Fluoride	Purex	Aqueous solution containing tin, fluoride, residual plutonium, impurities and spent processing reagents
Graphite	MEO/Purex	Aqueous solution containing graphite, residual plutonium and spent processing reagents
Inorganic	MEO/Purex	Aqueous solution containing inorganics, residual plutonium and spent processing reagents
Scrub Alloy	Purex	Aqueous solution containing americium, aluminum, residual plutonium and spent processing reagents

No process effluents would be released to surface water or groundwater. All the process effluents would be pumped from the canyon to the High-Level Waste system. The liquids would be stored in tanks pending processing. The impacts of these operations would be low (DOE 1994c). The americium and residual plutonium would be vitrified in canisters in the Defense Waste Processing Facility. The numbers of canisters that would be generated from each processing technology are presented in Sections 4.2 through 4.11.

Decontaminated aqueous solutions containing tin, fly ash, carbon steel, calcium, magnesium, graphite, inorganics, aluminum, fluoride, spent processing reagents and other impurities would be transferred to the Z-Area Saltstone Treatment and Disposal Facility. The resultant non-hazardous stabilized waste form (saltstone) would be disposed of in engineered vaults in accordance with the permit from the State of South Carolina. The impacts on groundwater quality from saltstone disposal would be very low (DOE 1994c). The number of cubic meters of saltstone that would be generated from each processing technology are presented in Sections 4.2 through 4.11.

4.13.3 Los Alamos National Laboratory

If any materials are sent to the Los Alamos National Laboratory under this EIS, they would be processed at Technical Area 55 (TA-55). Effluents would consist of water and filtrate. The materials, processing technologies, and effluents are presented in **Table 4–59**.

Table 4–59 Process Effluents at Los Alamos National Laboratory

Residue Category	*Processing Technology*	*Effluent Description*
IDC 365, 413 & 427 Salts	Acid Dissolve	755 kg water 9,320 kg filtrate
Other Direct Oxide Reduction Salts	Acid Dissolve	1,445 kg water 18,310 kg filtrate

No process effluents would be released to surface water or groundwater. All the process effluents would be transferred from TA-55 to the Radioactive Liquid Waste Treatment Facility at TA-50, where they would be treated using "as low as reasonably achievable" and "best available technology" processes. Any water released from that facility would be small and in accordance with the facility's National Pollution Discharge Elimination System permits.

4.14 IMPACTS OF POST-PROCESSING STORAGE

Under all of the alternatives, the products and some of the wastes from processing would be placed in storage for some period of time following processing. Under Alternative 1, stabilized residues would be placed in indefinite storage at Rocky Flats. Under Alternative 3, plutonium oxide would be stored for an extended period, until such time as it is processed for disposition. Materials designated for disposal at WIPP (i.e., stabilized residues and other transuranic wastes) would need to be stored until they could be scheduled for transportation to WIPP. If WIPP does not open or if its opening is delayed, it may be necessary to store these materials for an extended period of time.

The estimated amounts of products and wastes that would be generated at each site under the Preferred Alternative are presented in Section 4.21.1. Similarly, the estimated maximum amount of each product and waste that could be generated at each site is presented in Section 4.23. These generation estimates represent upper limits of storage requirements. DOE might need to construct new waste storage buildings if shipments to WIPP are delayed. The impacts of this construction would be low because the buildings would be light-weight metal or fabric structures on previously-disturbed land.

4.14.1 Impacts of Incident-Free Storage

Under incident-free conditions, the impacts of storage would be limited to radiological exposures to involved workers. No member of the public would be exposed to radiation from materials in storage unless a serious accident occurred. Similarly, there would be no potential exposures from nonradioactive hazardous chemicals because stabilization activities under all alternatives would prevent chemical exposures. The maximally exposed individual worker would receive a dose no higher than 2,000 mrem per year. Based on past experience at Rocky Flats, dose to the involved worker population from storage of stabilized residues is assumed to be directly proportional to the number of drums in storage. The involved worker dose rate from storage of stabilized residues is assumed to be 6.4 person-rem per year per 10,000 drums in storage.

Plutonium produced by separation processing at the Savannah River Site would be stored in the Actinide Packaging and Storage Facility (currently under construction) when it becomes operational (currently scheduled for 2001). Worker dose from storage in this facility is expected to be zero because no workers will go inside the facility. All inspections and handling will be performed with robotics. Nevertheless, in this section DOE made the conservative assumption that the worker doses for plutonium storage would be equal to those for stabilized residues storage: 6.4 person-rem per year per 10,000 drums.

4.14.1.1 Interim Storage of Stabilized Residues in the No Action Alternative

Under the No Action Alternative (Alternative 1), the stabilized residues would remain at Rocky Flats indefinitely. For the purpose of analysis, the storage period is assumed to be 20 years. This assumption is consistent with DOE's Notice of Intent (DOE 1996e) and DOE's Waste Management PEIS (DOE 1997c). The total number of drums of stabilized residues in the No Action Alternative could be as high as about 20,300 drums. This alternative would require the construction of new light-weight storage buildings at Rocky Flats. Multiplying the number of drums by 20 years and 6.4 person-rem per year per 10,000 drums yields a total of 260 person-rem for the total worker dose. The number of latent cancer fatalities associated with this dose is 0.1 latent cancer fatalities. This is much less than one, so DOE would not expect any workers to incur a latent cancer fatality from this storage.

4.14.1.2 Lag Storage

Lag storage would occur for transuranic waste under all alternatives and for stabilized residues with variances under Alternative 4. These materials would be waiting for shipment to WIPP. Lag storage would also occur for plutonium oxide from the processing of salt residues at Los Alamos National Laboratory. It is not possible to predict the duration of lag storage for any alternative because the duration would depend on the future availability of transportation, capacity at the receiving facility, etc.

Under the Preferred Alternative, DOE would generate about 18,400 drums of stabilized residues, 3,200 drums of transuranic waste, and 607 kg of plutonium at all three sites combined. All of this material could require some lag storage for some period of time. Assuming DOE places four kilograms of plutonium in each plutonium storage container, there could be a total of about 21,800 drums requiring lag storage at various times and for various durations at the three sites. If the average lag storage duration for all these materials is assumed to be one-half year, then multiplying by 6.4 person-rem per year per 10,000 drums yields a total worker dose of 7.0 person-rem. The number of latent cancer fatalities associated with this dose is 0.003 latent cancer fatalities. This is much less than one, so DOE would not expect any workers to incur a latent cancer fatality from this storage.

By examining the tables of products and wastes in Sections 4.2 through 4.11, the maximum amount of material that could require lag storage at all three sites under any combination of processing technologies can be estimated. The result is that there could be a total of about 42,000 drums requiring lag storage at various times and for various durations at the three sites. If the average lag storage duration is again assumed to be one-half year, then the total worker dose would be less than 14 person-rem. DOE would not expect any workers to incur a latent cancer fatality from such a small dose.

4.14.1.3 Storage of Transuranic Waste if Shipments to WIPP are Delayed

Every processing technology in this EIS would generate some transuranic waste and DOE plans to dispose of it in WIPP. The processing technologies in Alternative 4 would also generate stabilized residues, which could be disposed of in WIPP as transuranic waste. If the shipments to WIPP are delayed, then the inventories of transuranic waste and stabilized residues with variances would be placed in interim storage at the processing sites.

As discussed under lag storage above, DOE would generate about 18,400 drums of stabilized residues and 3,200 drums of transuranic waste under the Preferred Alternative. If all 21,600 drums of this material were placed in interim storage, then the worker dose would be about 14 person-rem per year. The number of latent cancer fatalities associated with this dose rate is 0.007 latent cancer fatalities per year. This is much less than one, so DOE would not expect any workers to incur a latent cancer fatality from this storage.

By examining the tables of products and wastes in Sections 4.2 through 4.11, the maximum amount of stabilized residues and transuranic waste that could require interim storage at all three sites under any combination of processing technologies can be estimated. The result is that there could be a combined total of about 42,000 drums requiring such storage in shipments to WIPP are delayed. The total worker dose rate could be as high as about 27 person-rem per year at all three sites combined. The number of latent cancer fatalities associated with this dose rate is about 0.01 latent cancer fatalities per year. This is much less than one, so DOE would not expect any workers to incur a latent cancer fatality from this storage.

4.14.2 Impacts of Accidents During Storage

In accident situations, it would be possible for some radioactive material to be released from the containers, so the offsite public could be affected. The impacts due to accidents during storage would not be directly proportional to the number of drums in storage, but rather they would depend more on the form of the packaging and the amounts of plutonium in the materials. The estimated impacts of storing stabilized residues, transuranic waste, and plutonium oxide are presented in **Tables 4–60** and **4–61**. The details of the impact calculations for accidents during storage are given in Appendix D.

Except for the 20 years of storage assumed for the No Action Alternative, the risks are given on an annual basis because the duration of this storage is impossible to determine. The highest accident risks to all three receptors would occur under the No Action Alternative due to the extended storage time.

4.15 Impacts of Final Transportation and Disposal/Disposition

4.15.1 Final Transportation

After interim storage at the processing sites, the many of the products and wastes generated from processing the Rocky Flats plutonium residues and scrub alloy would be transported to other sites for disposal or long-term storage. The impacts of this transportation are outside the scope of this EIS, but they are discussed briefly in Appendix E, Section E.6.5 and analyzed in other EISs prepared by DOE.

The environmental impacts of transporting the transuranic waste generated during processing of the plutonium residues are included in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997g). An approximation of the contribution to these total transportation impacts that may be attributable to the actions addressed in this EIS can be obtained by comparing the quantity of transuranic waste analyzed in the WIPP SEIS II and in this EIS. The quantity of stabilized or repackaged residues and transuranic waste generated in the preferred alternative of this EIS is estimated to be 20,800 drums (4,300 cubic meters). This is about 2.5 percent of the capacity of WIPP for transuranic waste. In the WIPP SEIS II the accident-free population impacts were estimated to be about 3.0 latent cancer fatalities to the public and 0.3 latent cancer fatalities to the truck crews. The highest lifetime accident-free impact to the maximally exposed individual was a 0.0085 probability of a latent cancer fatality. The aggregate potential truck accident impacts to populations along all transportation routes was estimated to be 0.4 latent cancer fatalities.

Low-level and possibly low-level mixed waste would also be generated as a result of processing the residues and scrub alloy. The environmental impacts of transporting these wastes are included in the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997c).

Table 4–60 Frequencies and Consequences of Accidents During Storage

Alternative	Accident Scenario	Accident Frequency (per year)	Offsite Public Maximally Exposed Individual Consequences		Offsite Public Population Consequences		Noninvolved Onsite Worker Consequences	
			Dose (mrem)	Probability of a Latent Cancer Fatality	Dose (person-rem)	Number of Latent Cancer Fatalities	Dose (mrem)	Probability of a Latent Cancer Fatality
Alternative 1 (No Action) Storage at Rocky Flats after Processing	Earthquake (Bldg. 371)	0.000094	306	0.00015	4,250	2.1	3,570	0.0014
Alternative 2 (without Plutonium Separation) Storage at Rocky Flats after Processing	Earthquake (Butler Bldg.)	0.002	52	0.000026	908	0.5	605	0.00024
Alternative 3 (with Plutonium Separation) Storage at Rocky Flats after Processing	Earthquake (Bldg. 371)	0.000094	2,460	0.0012	30,700	15	22,100	0.018
Storage at Rocky Flats after Preprocessing or Offsite Processing	Earthquake (Bldg. 371)	0.000094	1,850	0.00093	22,200	11	15,000	0.0060
Storage at Savannah River Site after Processing in H-Canyon	Earthquake (APSF Vault)	0.00001	100	0.000050	3,990	2.0	33,900	0.027
Storage at Los Alamos National Laboratory after Processing	Earthquake (TA-55 Vault)	0.000019	29,500	0.030	38,800	19	318,000	0.25
Storage at Savannah River Site after Processing at Los Alamos National Laboratory	Earthquake (APSF Vault)	0.00001	435	0.00022	15,500	7.8	109,000	0.087
Alternative 4 (Combination Alternative) Storage at Rocky Flats after Processing	Earthquake (Butler Bldg.)	0.002	67	0.000034	1,170	0.6	783	0.00031

APSF = Actinide Packaging and Storage Facility TA = technical area

Table 4–61 Risks of Accidents During Storage

Alternative	*Accident Scenario*	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality per year)*	*Offsite Public Population Risk (Number of Latent Cancer Fatalities per year)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality per year)*
Alternative 1 (No Action)				
Storage at Rocky Flats after Processing for 20 years	Earthquake (Bldg. 371)	1.4×10^{-8} per yr 2.9×10^{-7} per 20 yrs	0.00020 per yr 0.0040 per 20 yrs	1.3×10^{-7} per yr 2.7×10^{-7} per 20 yrs
	Composite	9.1×10^{-8} per yr 1.8×10^{-6} per 20 yrs	0.0016 per yr 0.031 per 20 yrs	8.5×10^{-7} per yr 0.000017 per 20 yrs
Alternative 2 (without Plutonium Separation)				
Storage at Rocky Flats after Processing	Earthquake (Butler Bldg.)	5.2×10^{-8}	0.00091	4.8×10^{-7}
	Composite	5.2×10^{-8}	0.00091	4.9×10^{-7}
Alternative 3 (with Plutonium Separation)				
Storage at Rocky Flats after Processing	Earthquake (Bldg. 371)	1.2×10^{-7}	0.0014	1.7×10^{-6}
	Composite	2.0×10^{-7}	0.0029	2.5×10^{-6}
Storage at Rocky Flats after Preprocessing for Offsite Processing	Earthquake (Bldg. 371)	8.7×10^{-8}	0.0011	5.6×10^{-7}
	Composite	8.7×10^{-8}	0.0011	5.6×10^{-7}
Storage at Savannah River Site after Processing in H-Canyon	Earthquake (APSF Vault)	5.0×10^{-10}	0.000020	2.7×10^{-7}
	Composite	5.0×10^{-10}	0.000020	2.7×10^{-7}
Storage at Los Alamos National Laboratory after Processing	Earthquake (TA-55 Vault)	5.6×10^{-7}	0.00037	4.8×10^{-6}
	Composite	5.7×10^{-7}	0.00037	4.9×10^{-6}
Storage at Savannah River Site after Processing at Los Alamos National Laboratory	Earthquake (APSF Vault)	2.2×10^{-9}	0.000078	8.7×10^{-7}
	Composite	2.2×10^{-9}	0.000078	8.7×10^{-7}
Alternative 4 (Combination Alternative)				
Storage at Rocky Flats after Processing	Earthquake (Butler Bldg.)	6.7×10^{-8}	0.0012	6.3×10^{-7}
	Composite	6.8×10^{-8}	0.0012	6.3×10^{-7}

APSF = Actinide Packaging and Storage Facility TA = technical area

Impacts from transportation of plutonium metal and oxides, which would be produced by processing residues and scrub alloy with plutonium separation (Alternative 3), are described in the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* (Storage and Disposition Programmatic EIS) (DOE 1996a). If Alternative 3 (processing with plutonium separation) is implemented at Rocky Flats or Los Alamos National Laboratory for the electrorefining and molten salt extraction salt residues, the resulting plutonium product could have special management requirements. These residues have a high americium content, and most of the non-Purex separation processes bring considered for this category would not remove the americium from the plutonium. Because americium emits gamma radiation, shielded containers would be required for storage and transportation of this mixture of plutonium and americium.

DOE plans to consolidate the storage of weapon-usable plutonium by upgrading existing and planned facilities at the Pantex Plant in Texas and the Savannah River Site in South Carolina. After certain conditions are met, most plutonium now stored at Rocky Flats would be moved to the Pantex Plant and the Savannah River Site (DOE 1997d). The transportation and long-term storage of this plutonium is analyzed in DOE's *Surplus Plutonium Disposition Draft EIS,* which was issued in July 1998 (DOE 1998b).

4.15.2 Disposal/Disposition

The impacts of disposal and/or disposition of the products and wastes generated from processing the Rocky Flats plutonium residues and scrub alloy are outside the scope of this EIS, but they are analyzed in other EISs prepared by DOE.

Products and wastes that result from processing the residues and scrub alloy according to the No Action Alternative would be stored at Rocky Flats until decisions are made concerning their disposition. Accordingly, no disposal impacts can be estimated at this time.

If the residues and scrub alloy are processed according to the Process without Plutonium Separation Alternative, the residual product will be a transuranic waste that meets the WIPP waste acceptance criteria. The environmental impacts of disposing of the transuranic waste from the residues are included in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997g) and these impacts are estimated to be low. Further NEPA review would be needed before transuranic wastes generated directly from scrub alloy could be disposed of at WIPP.

Secondary wastes classified as low-level or low-level mixed waste may also be generated as a result of the processes to stabilize the residues and scrub alloy. The environmental impacts of disposing of these secondary wastes are included in the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997c) and these impacts are estimated to be low.

If the residues and scrub alloy are processed according to the Process with Plutonium Separation Alternative, two principal products would result: (1) plutonium metal or plutonium oxide that contains greater than 50 percent plutonium and (2) transuranic waste. In addition, secondary wastes classified as low-level or low-level mixed waste may be generated during the process. High-level waste and saltstone would be generated if processing takes place at the Savannah River Site.

Decisions have not yet been made concerning the disposition of the plutonium metal and plutonium oxide in DOE's inventory. However, current DOE policy will ensure that any plutonium separated and/or stabilized under this EIS will not be used for nuclear explosive purposes (DOE 1994b). The environmental impacts of further stabilization of this material are analyzed in the *Surplus Plutonium Disposition Draft EIS* issued in July

1998 (DOE 1998b). No environmental impact statement has yet been published on the disposal of stabilized plutonium in a monitored geologic repository.

Two additional waste streams would be generated at the Savannah River Site if the residues or scrub alloy are processed there. These processes would produce a liquid waste that would be sent to the high-level waste tank farm and mixed with high-level wastes. When this waste is processed, part of it would be sent to the Defense Waste Processing Facility to be vitrified as high-level waste and another fraction would be sent to the Saltstone Manufacturing and Disposal Facility to be solidified as low-level waste. The high-level waste fraction of this waste would be processed in the Defense Waste Processing Facility. The product of this processing would be canisters filled with high-level waste glass, which would be stored in the Glass Waste Storage Building at the Savannah River Site. The environmental impacts of these processing and storage activities are addressed in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE 1994c) and these impacts are estimated to be low.

The high-level waste fraction of this waste would be disposed of in the monitored geologic repository for defense high-level waste and spent nuclear fuel. The environmental impacts of disposing of the high-level waste fraction of this material will be addressed with other high-level waste. The impacts of disposing of saltstone at the Savannah River Site are also addressed in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE 1994c) and these impacts are estimated to be low.

4.16 ENVIRONMENTAL JUSTICE

As discussed in Appendix F, Executive Order 12898 directs Federal agencies to address disproportionately high and adverse health or environmental effects of alternatives on minority populations and low-income populations.

Chapter 3 and Appendix F describe the distributions of minority and low-income populations in the vicinity of the three candidate processing sites and potential intersite transportation routes. Analyses described elsewhere in this chapter predict only minimal risks to health and safety from the management of plutonium residues and scrub alloy currently stored at Rocky Flats. Analyses of risks from incident-free operations and from accidents under all alternatives yield estimates that are much less than 1 latent cancer fatality in the public population. Because none of the alternatives would cause high and adverse consequences to the population at large, no minority or low-income populations would be expected to experience disproportionately high and adverse consequences.

4.17 COSTS, PROCESSING DURATIONS, AND UNCERTAINTIES

This section summarizes costs, processing durations, and uncertainties for the Minimum Cost Management Approach, the Preferred Alternative, the No Action Alternative, and the Minimum Duration Management Approach. Detailed supporting data and calculations for the individual processing technologies are presented in Appendix G. All costs are presented in undiscounted 1997 dollars.

4.17.1 Cost Estimation Procedures

All costs for individual alternatives and management approaches are rolled-up totals from six individual cost categories:

- Facilities and equipment
- Labor and site overheads

- Transuranic waste, including variable costs of disposal at WIPP
- Low-level waste at Rocky Flats and Los Alamos National Laboratory
- Other materials storage, shipping, and disposal costs, including costs at the Savannah River Site, and
- Costs related to interim storage of stabilized residues and transuranic waste at Rocky Flats (No Action Alternative).

Facilities and equipment costs are divided into two groups: (1) costs that have been incurred, are being incurred, or will be incurred in support of the plutonium residues clean-up independent of the Records of Decision in the present EIS, and (2) costs that will be incurred pursuant to the Records of Decision in the present EIS. The former group includes costs to bring the facilities into compliance with DOE regulations and Defense Nuclear Facilities Safety Board recommendations, to upgrade the facilities for their missions, to install facility-specific equipment, and to complete operational readiness reviews and startup tests. These costs, plus ongoing research and development costs, are allocable to the plutonium residues program, but are not incremental (i.e., decisional) in the present EIS. Allocable costs in most alternatives are $180 million for facilities and equipment (i.e., an average of six facilities at $30 million per facility) and $10 million for research and development. Costs for expensive, specialized pieces of equipment used in a small number of processing technologies are directly assigned to these technologies and are decisional in this EIS. Processing costs are based on facilities and equipment that are (or would be) up-and-running for this program rather than on developmental technologies. Decommissioning costs at all three sites are considered part of site-wide programs outside the scope of this EIS.

Labor costs and site overheads are estimated as a function of the number of hours that operations and support personnel are exposed to radiation (not the amount of radiation they are exposed to). These exposure-hours are then multiplied by a factor that relates allocable labor hours at the site to exposure-hours. The more allocable labor-hours per exposure-hour, the greater the multiplier. The multiplier captures the hours spent by: (1) exposed individuals in non-exposed activities (e.g., preparing for operations, down-time during maintenance, and administrative matters), (2) non-exposed individuals in direct support of the operations, and (3) indirect site support personnel. The relationships between exposure-hours and allocable labor costs are based on empirical observations from a sample of recent residues management activities at Rocky Flats.

Transuranic waste costs are based on unit costs for packaging, characterizing, and shipping drums of transuranic waste and stabilized residues to WIPP. Variable costs for disposing of transuranic waste at WIPP are included for each processing technology. Other waste treatment and disposal costs, including low-level waste, are allocated on a similar unit cost basis, including costs for disposal of high-level waste in a monitored geologic repository.

Other materials storage, shipping, and disposal costs include shipping materials from Rocky Flats to the Los Alamos National Laboratory or the Savannah River Site for processing, storing 3013 canisters of refined plutonium, disposing of saltstone at the Savannah River Site, producing vitrified high-level waste at the Savannah River Site Defense Waste Processing Facility, disposing of vitrified high-level waste at the monitored geologic repository, and disposing of refined plutonium in later DOE programs.

Assuming Records of Decision in 1998 selecting the No Action Alternative, processing activities would continue until about 2006. Stabilized residues and transuranic waste generated during the stabilization processes are assumed to remain on site for an additional twenty years. For cost purposes, all stabilized residues are assumed to be qualified for shipment to WIPP at the same level of characterization as other transuranic wastes before being shipped to WIPP in 2025.

4.17.2 Cost Factors

Five factors explain most of the costs and cost relationships described in this EIS. These cost factors can be summarized as follows:

- **Labor and Labor Multipliers** — Labor-related costs are based on the number of hours operators are exposed and a multiplier to account for non-exposure hours, indirect hours, site labor, etc. The multipliers range from 1.1 for repackaging and similar non-processing activities, to 3.1 for pyro-oxidation, distillation, and processes with similar requirements, 4.2 for vitrification, blend down, and similar processes, and 5.8 for "wet processes" such as sonic washing, water leaching, mediated electrochemical oxidation, and Purex processing at the Savannah River Site. Multiplied labor costs may overstate the *incremental* out-of-pocket costs to DOE since many site and indirect costs are fixed or semi-fixed.

- **Duration** -- In general, the shorter the duration of processing, the lower the costs. As a practical matter, the only processing technologies for which the differences in *incremental* labor costs to DOE are likely to be significant are those with much higher durations of exposure-hours among the direct workers.

- **Capital Expenditures** -- Processing technologies that require the acquisition of highly specific large-scale equipment (e.g., equipment for mediated electrochemical oxidation at Rocky Flats or the Savannah River Site or distillation at the Los Alamos National Laboratory) are never among the least costly technologies. There are no processing technologies for which savings on operations can offset the costs for new, large-scale equipment.

- **Transuranic Waste** -- Processing technologies that create large numbers of drums of transuranic waste or stabilized residues generate large costs for waste packaging, characterization, and shipping. Variable costs for disposal at WIPP are a minor cost factor.

High Assay Materials— Processing technologies that ship the materials with the highest plutonium assays to the Savannah River Site for Purex processing tend to be among the least expensive options. This is because (1) Purex processing costs at the Savannah River Site vary according to total residue mass while processing costs at Rocky Flats and the Los Alamos National Laboratory vary according to plutonium mass, and (2) Purex processing at the Savannah River Site F-Canyon requires no large capital additions while many of the processes for high assay residues at either of the other sites require expensive capital additions.

4.17.3 Cost of the Minimum Cost Management Approach

DOE estimates that the Minimum Cost Management Approach has an allocable cost of about $428 million. About $180 million of this cost has been or will be incurred at Rocky Flats in support of the plutonium residues program independent of the present EIS. Another $10 million will be incurred at Rocky Flats or Los Alamos National Laboratory in fiscal year 1998 for development and testing of the processing technologies independent of the present EIS. Of the remaining $238 million, about $185 million is attributable to labor, waste processing, site overheads, etc. at the individual sites. About $47 million is attributable to disposition of separated plutonium outside of this EIS. Itemized equipment (i.e., distillation apparatus at Rocky Flats) is estimated to cost about $4 million. Variable costs for disposal at WIPP are about $1 million. The Minimum Cost Management Approach would require an estimated 3.2 years of calendar time at Rocky Flats, with Building 707, Module A requiring the most processing time. **Table 4-62** shows the individually allocable costs for each processing technology and the totals for the various categories.

Among the major residue categories, the least costly processing technology for the ash residues is some form of repackaging at Rocky Flats under Alternative 4. With the exception of Purex processing at the Savannah River Site for sand, slag, and crucible, the least costly technologies for managing the ash residues are the same as the preferred processing technologies. For the salt residues, the only category where the least costly technology is the same as the preferred processing technology is repackaging and shipment to WIPP for other direct oxide reduction salts under Alternative 4. The least costly processing technology for both categories of electrorefining and molten salt extraction salts is distillation at Rocky Flats. This technology requires about $4 million in itemized equipment costs at Rocky Flats. The least costly processing technology for the high assay direct oxide reduction salts is salt scrub at Rocky Flats followed by Purex processing at the Savannah River Site F-Canyon.

Table 4–62 Individually Allocable Costs of the Minimum Cost Processing Technologies [a]

Material Category	*Minimum Cost Processing Technology*	*Approximate Cost ($M)*	*Preferred Processing Technology?*
Incinerator Ash	Repackage at Rocky Flats under Alternative 4	58	Yes
Sand, Slag, and Crucible	Repackage at Rocky Flats under Alternative 4	11	No
Graphite Fines	Repackage at Rocky Flats under Alternative 4	4	Yes
Inorganic Ash	Repackage at Rocky Flats under Alternative 4	8	Yes
Molten Salt Extraction and Electrorefining Salts IDC 409	Distillation at Rocky Flats	18[b]	No
Other Electrorefining and Molten Salt Extraction Salts	Distillation at Rocky Flats	45[b]	No
Direct Oxide Reduction Salts, IDCs 365, 413, 427	Salt scrub at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	13	No
Other Direct Oxide Reduction Salts	Repackage at Rocky Flats under Alternative 4	8	Yes
Aqueous-contaminated Combustibles	Blend Down at Rocky Flats	2	No
Organic-contaminated Combustibles	Blend Down at Rocky Flats	1	No
Dry Combustibles	Blend Down at Rocky Flats	1	No
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	18	Yes
Ful Flo Filter Media	Blend Down at Rocky Flats	4	Yes
HEPA IDC 338 Filter Media	Blend Down at Rocky Flats	10	No
Other HEPA Filter Media	Vitrify at Rocky Flats	1	No
Sludge (IDC 089, 099, 332)	Vitrify at Rocky Flats	1	No
Other Sludge	Blend Down at Rocky Flats	3	No
Glass	Neutralize/Dry at Rocky Flats under Alternative 4	1	Yes
Graphite	Repackage at Rocky Flats under Alternative 4	8	Yes
Inorganic	Repackage at Rocky Flats under Alternative 4	2	Yes
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	20	Yes
Labor, site, processing, & disposal costs[b,c,d]		~234	

Material Category	*Minimum Cost Processing Technology*	*Approximate Cost ($M)*	*Preferred Processing Technology?*
Of which, materials disposition costs[d]		~47	
Plus, itemized equipment costs[d]		~4	
Subtotal - decisional costs[d]		~238	
Common facilities costs at Rocky Flats[e]		~180	
R&D at Rocky Flats and Los Alamos National Laboratory[e]		~10	
Total		~428	

[a] Excluding the no action processing technologies, which would generate stabilized residues without variances for disposal in WIPP.
[b] Excluding $2 million of $4 million in itemized distillation equipment costs.
[c] Because costs for many of the minor residues are significantly less than $1 million but are shown as $1 million, the sum of the individual costs on the table exceeds the actual total.
[d] Costs that DOE would incur by selecting the specified processing technologies.
[e] Costs that DOE expects to incur regardless of the processing technologies selected.

4.17.4 Cost of the Preferred Alternative

The Preferred Alternative adds an estimated $96 million in decisional costs to the Minimum Cost Management Approach (**Table 4-63**). This additional cost is attributable to the processing technologies for sand, slag, and crucible; electrorefining and molten salt extraction salts; high assay direct oxide reduction salts; combustibles; filters; and sludges. DOE prefers to incur the higher costs of the preferred processing technologies rather than accept the technical and schedule uncertainties associated with the less costly processing technologies. The Preferred Alternative requires about 5.5 years at Rocky Flats, with operations at Building 707, Module E taking the longest. The major cost/uncertainty tradeoffs are as follows:

Sand, Slag, and Crucible—The preferred processing technology of repackaging at Rocky Flats for Purex processing at the Savannah River Site is about $25 million more expensive than repackaging under Alternative 4. DOE prefers Purex processing at the Savannah River Site because there is a high degree of technical and schedule uncertainty related to characterizing the sand, slag, and crucible under Alternative 4. While DOE believes that the material could be qualified for shipment to WIPP, the characterization process would be lengthy and would create very large cost and scheduling concerns at the Savannah River Site if qualification issues could not be resolved and the material were ultimately required to be shipped to the Savannah River Site.

IDC 409 Electrorefining and Molten Salt Extraction Salts—The preferred processing technology of pyro-oxidation followed by repackaging under Alternative 4 for the high assay electrorefining and molten salt extraction salts is virtually the same cost as the minimum cost processing technology of distillation at Rocky Flats. DOE prefers repackaging under Alternative 4 because it has much less technical and schedule uncertainty.

Other Electrorefining and Molten Salt Extraction Salts—The preferred processing technology of pyro-oxidation followed by repackaging under Alternative 4 for the other electrorefining and molten salt

extraction salts is about $21 million more expensive than the minimum cost processing technology of distillation at Rocky Flats. DOE prefers repackaging under Alternative 4 because it has much less technical and schedule uncertainty.

IDC 365, 413, and 427 Direct Oxide Reduction Salts—The preferred processing technology is to ship the high assay direct oxide reduction salts (most of which are IDCs 365, 413, and 427) to the Los Alamos National Laboratory for acid dissolution and to repackage the remaining [IDC 365, 413, and 427] direct oxide reduction salts under Alternative 4. Because DOE needs to retain the flexibility to ship all the high assay direct oxide reduction salts to the Los Alamos National Laboratory in the event repackaging under Alternative 4 is not feasible, the cost summary for the preferred alternative shows the costs for the more costly of the two processing options, i.e., shipping all 727 kg to the Los Alamos National Laboratory for acid dissolution. These costs are about $5 million higher than either repackaging all the high assay direct oxide reduction salts under Alternative 4 or repackaging and Purex processing the salts at the Savannah River Site. The "hybrid" is about $3 million more expensive than either repackaging all the high assay direct oxide reduction salts under Alternative 4 or repackaging and Purex processing the salts at the Savannah River Site. Shipment of the salts to the Los Alamos National Laboratory rather than repackaging under Alternative 4 reduces the duration of activities at Rocky Flats' Building 707, Module E by about 1-2 months.

Other Direct Oxide Reduction Salts—The preferred processing technology of pyro-oxidation followed by repackaging under Alternative 4 for the other direct oxide reduction salts is the least costly technology. DOE recognizes the possibility that some of the other direct oxide reduction salts may not meet the requirements for repackaging under Alternative 4. In this case, DOE prefers to ship the salts to the Los Alamos National Laboratory for acid dissolution. DOE cannot determine how much other direct oxide reduction salt could be shipped to the Los Alamos National Laboratory until each can of material is examined. In the event all of the other direct oxide reduction salts are shipped to the Los Alamos National Laboratory, the additional cost to DOE for processing is estimated at about $12 million. Shipment of the salts to the Los Alamos National Laboratory rather than repackaging under Alternative 4 reduces the duration of activities at Rocky Flats' Building 707, Module E by a few months.

Combustibles—The preferred processing technologies of neutralize/dry, thermal desorption/steam passivation, and repackaging, (all under Alternative 4) for aqueous-contaminated, organic-contaminated, and dry combustibles, respectively, are about $10 million more expensive than blending down the residues. Blend-down generates fewer drums for disposal at WIPP (220 compared to 1,008) and requires 1/2 year less time at Rocky Flats. However, blend down has a high technical uncertainty for addressing the safety issues related to nitric acid-contaminated and organic-contaminated combustibles and radiolysis. It is not known if the dilution of the nitrates would address the potentially explosive formation of nitrate cellulose or if the dilution of the combustible organic material in the combustibles would prevent the potential generation of hydrogen gas from radiolysis. The time needed to verify that blend down would eliminate the safety issues would adversely affect the schedule for shutting down Rocky Flats.

IDC 338 High Efficiency Particulate Air Filters—The preferred processing technology of neutralize/dry under Alternative 4 is about $29 million more expensive than vitrification or blend down. Vitrification generates fewer drums for disposal at WIPP (656 compared with 3,361) and requires almost one year less processing time at Rocky Flats. However, HEPA filters have never been vitrified and thus present a high technical uncertainty. Blend down could be substituted for vitrification with fewer drums (572), slightly more processing time at Rocky Flats, and essentially no change in costs. However, blend down has a high technical uncertainty for addressing the safety issues related to nitric acid-contaminated filters. It is not known if the dilution of the nitrates would address the potentially explosive formation of nitrate cellulose

or if the dilution of the organic material in the HEPA filters would prevent the potential generation of hydrogen gas from radiolysis. The time needed to verify that blend down would eliminate the safety issues or to prove that vitrification works for HEPA filters would adversely affect the schedule for shutting down Rocky Flats.

Other Sludge—The preferred processing technology of filter/dry under Alternative 4 is about $9 million more expensive than vitrification or blend down. Vitrification generates fewer drums for disposal at WIPP (216 compared with 1,095) and requires about two months less processing time at Rocky Flats. However, vitrification has tested unsuccessfully on sludges and more testing would be needed to develop the process. Blend down could be substituted for vitrification with fewer drums (212), slightly more processing time at Rocky Flats, and essentially no change in costs. However, blend down has a high technical uncertainty for addressing the safety issues related to nitric acid-contaminated and solvent-contaminated sludges. It is not known if the dilution of the nitrates would address the potentially explosive formation of nitrate cellulose or if the dilution of the organic material in the sludges would prevent the potential generation of hydrogen gas from radiolysis. The time needed to verify that blend down would eliminate the safety issues or to prove that vitrification works for sludges would adversely affect the schedule for shutting down Rocky Flats.

For repackaged combustibles and filter media, DOE is severely limited in the amount of plutonium per drum it may ship to WIPP. This limitation (23.2 fissile gram-equivalent) is due to the amount of organic material that may interact with radionuclides to generate explosive conditions. Once the combustibles and filter media are changed from their original state by processes such as vitrification, pipe components can be used to pack the plutonium at up to 200 fissile gram-equivalent. This reduces the number of drums shipped to WIPP by more than a factor of eight. In the case of blending, the reduced drum count is due to the shredding process that precedes the blending process. Subject to the uncertainties described above, shredded combustibles and filters can be blended and placed in pipe components. Whole combustibles and filters, even if chemically neutralized, are too bulky for insertion in pipe components. The reduction in drum counts more than offsets the costs of the processing and the costs of the pipe components, thus making ostensibly more complicated processing technologies less expensive than the simple technology of stabilization through neutralization and repackaging.

Table 4–63 Costs of the Preferred Processing Technologies

Material Category	*Preferred Processing Technology*	*Approximate Cost, ($M)*	*Premium over Minimum Cost Processing Technology ($M)*
Incinerator Ash	Repackage at Rocky Flats under Alternative 4	58	--
Sand, Slag, and Crucible	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	36	25
Graphite Fines	Repackage at Rocky Flats under Alternative 4	4	--
Inorganic Ash	Repackage at Rocky Flats under Alternative 4	8	--
Molten Salt Extraction and Electrorefining Salts IDC 409	Pyro-oxidize, blend and repackage at Rocky Flats under Alternative 4	20	--[b]
Other Electrorefining and Molten Salt Extraction Salts	Pyro-oxidize and repackage at Rocky Flats under Alternative 4	68	21[b]
Direct Oxide Reduction Salts, IDCs 365, 413, 427	Ship some of the residue to the Los Alamos National Laboratory; pyro-oxidize, blend, and repackage the remaining residue at Rocky Flats under Alternative 4[f]	17	4

Material Category	*Preferred Processing Technology*	*Approximate Cost, ($M)*	*Premium over Minimum Cost Processing Technology ($M)*
Other Direct Oxide Reduction Salts	Pyro-oxidize and repackage at Rocky Flats under Alternative 4	8	--
Aqueous-contaminated Combustibles	Neutralize/Dry at Rocky Flats under Alternative 4	5	4
Organic-contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats under Alternative 4	6	5
Dry Combustibles	Repackage at Rocky Flats under Alternative 4	2	1
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	18	--
Ful Flo Filter Media	Blend Down at Rocky Flats	4	--
HEPA IDC 338 Filter Media	Neutralize/Dry at Rocky Flats under Alternative 4	39	29
Other HEPA Filter Media	Blend Down and repackage at Rocky Flats under Alternative 4	1	--
Sludge (IDC 089, 099, 332)	Blend Down and repackage at Rocky Flats under Alternative 4	1	--
Other Sludge	Filter/Dry at Rocky Flats under Alternative 4	12	9
Glass	Neutralize/Dry at Rocky Flats under Alternative 4	1	--
Graphite	Repackage at Rocky Flats under Alternative 4	8	--
Inorganic	Repackage at Rocky Flats under Alternative 4	2	--
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	20	--
Labor, site, processing, & disposal costs[b,c,d]		~334	~96
Of which, materials disposition costs[d]		~22	-25
Plus, itemized equipment costs[d]		0[b]	0[b]
Subtotal - Decisional Costs[d]		~334	~96
Common facilities costs at Rocky Flats[e]		~180	--
R&D Costs at Rocky Flats and Los Alamos National Laboratory[e]		~10	--
Total[b]		~524	~96

[a] Excluding the no action processing technologies, which would generate stabilized residues without variances for disposal in WIPP.

[b] If $2 million of the $4 million total for distillation equipment is allocated to this processing technology.

[c] Because costs for many of the minor residues are significantly less than $1 million but are shown as $1 million, the sum of the individual costs on the table exceeds the actual total.

[d] Costs that DOE would incur by selecting the specified processing technologies.

[e] Costs that DOE expects to incur regardless of the processing technologies selected

[f] Based on shipment of all 727 kg to the Los Alamos National Laboratory for acid dissolution. Costs would be lower if some portion of this residue is repackaged at Rocky Flats under Alternative 4.

4.17.5 Cost of the No Action Alternative

The No Action Alternative has an estimated undiscounted cost, exceeding $1.1 billion, of which $210 million is attributable to common facilities and equipment, $10 million is attributable to ongoing R&D, $446 million is attributable to individual processing technologies, and $460 million is attributable to storing stabilized residues and transuranic waste on site for twenty years. Disposal costs at WIPP are estimated at $3 million. No indirect costs are charged for deferring the return of the site to alternative uses.

4.17.6 Cost of the Minimum Duration Management Approach

Costs for the Minimum Duration Management Approach are presented in **Table 4-64.** Decisional costs are roughly midway between those of the Preferred Alternative and the Minimum Cost Management Approach. As compared to the Preferred Alternative, the Minimum Duration Alternative repackages the sand, slag, and crucible under Alternative 4, scrubs the other electrorefining and molten salt extraction salts for Purex processing at the Savannah River Site, pyro-oxidizes all the direct oxide reduction salts for processing at the Los Alamos National Laboratory, blends down all the combustibles and sludges, and vitrifies all of the high efficiency particulate filters and glass.

Table 4–64 Costs of the Minimum Duration Management Approach

Material Category	*Processing Technology*	*Approximate Cost, ($M)*	*Processing Time[a] Saved at Rocky Flats versus the Preferred Processing Technology*
Incinerator Ash	Repackage at Rocky Flats under Alternative 4	58	--
Sand, Slag, and Crucible	Repackage at Rocky Flats under Alternative 4	11	3 months
Graphite Fines	Repackage at Rocky Flats under Alternative 4	4	--
Inorganic Ash	Repackage at Rocky Flats under Alternative 4	8	--
Molten Salt Extraction and Electrorefining Salts IDC 409	Pyro-oxidize, blend and repackage at Rocky Flats under Alternative 4	19	--
Other Electrorefining and Molten Salt Extraction Salts	Salt Scrub at Rocky Flats, Purex Process at the Savannah River Site F-Canyon	86[b]	1.5 years
Direct Oxide Reduction Salts, IDCs 365, 413, 427	Pyro-Oxidize at Rocky Flats, Acid Dissolve at Los Alamos National Laboratory	17[b]	--
Other Direct Oxide Reduction Salts	Pyro-Oxidize at Rocky Flats, Acid Dissolve at Los Alamos National Laboratory	19[b]	4 months
Aqueous-contaminated Combustibles	Blend Down at Rocky Flats	2	2 months
Organic-contaminated Combustibles	Blend Down at Rocky Flats	1	5 months
Dry Combustibles	Blend Down at Rocky Flats	1	negligible
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	18	--
Ful Flo Filter Media	Blend Down at Rocky Flats	4	--
HEPA IDC 338 Filter Media	Vitrify at Rocky Flats	11	1 year
Other HEPA Filter Media	Vitrify at Rocky Flats	1	negligible
Sludge (IDC 089, 099, 332)	Blend Down and repackage at Rocky Flats under Alternative 4	1	--

Material Category	*Processing Technology*	*Approximate Cost, ($M)*	*Processing Time[a] Saved at Rocky Flats versus the Preferred Processing Technology*
Other Sludge	Blend Down at Rocky Flats	3	2 months
Glass	Vitrify at Rocky Flats	1	negligible
Graphite	Repackage at Rocky Flats at Rocky Flats under Alternative 4	8	--
Inorganic	Repackage at Rocky Flats at Rocky Flats under Alternative 4	2	--
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	20	--
Total Individual Costs[b,c,d]		~292	--
Of Which, Materials Disposition Costs[d]		~40	--
Plus Shared Equipment Costs[d]		0[b]	--
Subtotal - Decisional Costs[b,d]		~292	--
Common Facilities Costs at Rocky Flats[e]		~180	--
R&D Costs at Rocky Flats and Los Alamos National Laboratory[e]		~10	--
Total		~482	not additive

[a] Processing times are not additive because the facilities' schedules are not optimized.
[b] Program costs depend on whether the Savannah River Site uses F Canyon or H Canyon for Purex processing and whether the Los Alamos National Laboratory uses acid dissolution or water leach for the direct oxide reduction salts. Processing times at Rocky Flats are unaffected.
[c] Because costs for many of the minor residues are significantly less than $1 million but are shown as $1 million, the sum of the individual costs on the table exceeds the actual total.
[d] Costs that DOE would incur by selecting the specified processing technologies.
[e] Costs that DOE expects to incur regardless of the processing technologies selected

The result is a duration at Rocky Flats estimated at 2.6 years, with the longest duration at Building 707, Module E. This duration is the non-optimized sum of the durations of the shortest individual processing technologies for each material category. All tables in this EIS showing summed durations use the non-optimized sum of the shortest individual processing technologies.

4.17.7 Technical Uncertainties

Table 4-65 shows the processing technologies for the major residue categories according to their technical uncertainty. (Schedule uncertainties are summarized in Appendix G.) The low-uncertainty processing technologies are nearly free of technical uncertainty. The moderate-uncertainty processing technologies are riskier than the low-uncertainty processing technologies. The high-uncertainty processing technologies are at the boundary of technical acceptability and would carry very substantial costs if they were implemented and subsequently fail.

Table 4–65 Technical Uncertainties for Major Categories of Processing Technologies

Residue	*Low Uncertainty*	*Moderate Uncertainty*	*High Uncertainty*
Ash	Blend down, Purex Process at the Savannah River Site, Repackage (excluding sand, slag, and crucible)	Vitrification, Mediated Electrochemical Oxidation at the Savannah River Site, Calcine and Cement, Cement, Cold Ceramification	Repackage (sand, slag and crucible only)
Salt	Pyro-oxidation, Blend down (low mass/low assay granules), Acid Dissolution, Purex Process at the Savannah River Site, Repackage	Salt Scrub in preparation for Purex Process at the Savannah River Site	Distillation, Water Leach, Blend down (high mass/high assay chunks)
Combustibles	Neutralize/Dry, Repackage (dry only)	Mediated Electrochemical Oxidation, Sonic Wash, Thermal Desorption, Catalytic Chemical Oxidation	Blend down (nitric acid- and organic-contaminated residues)
Fluoride	Blend down (low mass/low assay granules), Purex Process at the Savannah River Site	Acid Dissolution	Blend down (high mass/high assay chunks)
Filter Media	Neutralize/Dry, Repackage (other HEPA filters only)	Vitrification, Mediated Electrochemical Oxidation, Sonic Wash	Blend down (nitric acid-contaminated residues)
Sludge	Blend down, Filter/Dry Repackage (IDC 089, 099, 332 only)	Sonic Wash, Acid Dissolution	Vitrification
Glass	Blend down, Neutralize/Dry	Vitrification, Mediated Electrochemical Oxidation	--
Graphite	Blend down, Repackage	Vitrification, Mediated Electrochemical Oxidation at the Savannah River Site, Cement	--
Inorganics	Blend down, Repackage	Vitrification, Mediated Electrochemical Oxidation, Mediated Electrochemical Oxidation at the Savannah River Site, Sonic Wash	--
Scrub Alloy	Purex Process at the Savannah River Site, Repackage	Calcine and Vitrify	--

Among the major residue categories, distillation of molten salt extraction salt residues at the Los Alamos National Laboratory carries the highest technical and economic uncertainties. Salt distillation in general is unproven at the scale proposed for the residues in this program. If new distillation equipment and related upgrades are required at the Los Alamos National Laboratory for the IDC 409 electrorefining and molten salt extraction salts, equipment costs could be as high as $37 million. Distillation of electrorefining and molten salt extraction salts (excluding IDC 409 salts) at the Los Alamos National Laboratory would require $115 million in capital expenditures for distillation equipment, facilities upgrades, and vault upgrades over a 6-8 year period. The americium-plutonium output from the distillation process would be packaged in 3013 containers and retained at the Los Alamos National Laboratory pending approval in the present EIS or related EISs (e.g., disposition of fissile materials) to ship the plutonium to the Savannah River Site.

In the case of the IDC 409 molten salt extraction salts and the IDCs 365, 413, and 427 direct oxide reduction salts, blending prior to repackaging in the preferred alternative is required. Although blending and repackaging is a low uncertainty processing technology overall, some individual cans of salts may have chunks of high assay, high mass materials that cannot be blended down without new and/or unproven technologies and equipment. For these salt chunks, some form of separation is preferred. In the case of the direct oxide reduction salts, especially but not exclusively the high assay IDC 365, 413, and 427 categories, the incremental cost of acid dissolution at the Los Alamos National Laboratory would be about $17 million more than repackaging under Alternative 4. Costs for water leaching the direct oxide reduction salts are similar but

technical risks are higher. Pyro-oxidation of direct oxide reduction salts as a precursor to acid dissolution (not pyro-oxidation as a stand-alone process) is unproven using the existing technologies at Rocky Flats.

Alternatively, the salts could be scrubbed at Rocky Flats for Purex processing at the Savannah River Site. Although salt scrub is a low-uncertainty process in general, scrubbing of less pure salts or salts that have absorbed moisture during storage creates moderate to high technical uncertainties, including worker exposure. A small but non-trivial portion of the salts at Rocky Flats is likely to be in these categories. Development work on scrubbing off-specification salts would be required prior to or in parallel with the scrubbing operations. Finally, if the salts are pyro-oxidized in preparation for distillation, the Purex processing technology at Savannah River Site would be foreclosed.

Repackaging sand, slag, and crucible under Alternative 4 carries high technical uncertainties due to the potential for reactivity and pyrophoricity. Before sand, slag, and crucible could be certified for disposal at WIPP under this processing technology, Rocky Flats would have to conduct characterization activities well beyond the levels required for ordinary transuranic waste. The cost and duration of this characterization is uncertain but it would be a minimum of several months and several million dollars. If processing technologies for sand, slag, and crucible are deferred while the characterizations required for repackaging under Alternative 4 take place and repackaging is ultimately rejected, processing, shipping, and scheduling windows at Rocky Flats and the Savannah River Site would be adversely affected.

Ash vitrification is among the more uncertain of the moderate uncertainty technologies. The proposed approach to ash vitrification includes a calcination stage ahead of the vitrification stage. This increases the cost of vitrification, but reduces the uncertainty. Optimization studies are underway to determine if calcination can be bypassed without affecting the acceptability of the waste form.

Blending or vitrifying combustibles, filter media, and sludges carry various technical and schedule uncertainties as outlined in Section 4.17.4.

4.18 SOCIOECONOMICS

The socioeconomic impacts from the management of Rocky Flats' plutonium residues and scrub alloy depend on the management approach selected to manage all the materials. Socioeconomic impacts can only be estimated for management approaches rather than for individual technologies. In general, the processing technologies that require the most labor and generate the most transuranic waste generate the greatest socioeconomic impact.

Table 4-66 shows estimated allocable costs at Rocky Flats for materials and waste processing. The following points are important in interpreting the table:

- Expenditures on facilities upgrades and technology development (discussed in 4.17.1) are excluded from the table since these expenditures will be incurred independent of decisions in the present EIS.
- Expenditures relating to waste packages, shipping, disposal at WIPP, fissile materials disposition, and other off-site activities are excluded from the table since they do not create socioeconomic impacts at Rocky Flats.
- Annualized site spending, including allocations of existing and ongoing site overheads are in the range of $50-60 million for all management approaches except for the No Action Alternative.

- Annualized costs for the processing technologies are $20-40 million, with two or three processing technologies carried out concurrently. Most processing technologies require only a small fraction of a year to complete. Processing technologies for ash and salt residues, which may take several years, determine most of the impacts.

- The costs in the processing column include an allocation of fixed and semi-fixed site costs (e.g., security, administration, materials management) that will not be appreciably affected by the management of the plutonium residues but are allocable to the program.

- Socioeconomic impacts from management approaches other than the No Action Alternative are compared to the impacts from the No Action Alternative, not to a zero expenditure baseline. To the extent the expenditure profile in a management approach is similar to the expenditure profile for the No Action Alternative, the socioeconomic impacts from that management approach are similar.

Table 4–66 Estimated Spending at Rocky Flats by Activity for Each Processing Technology (excluding common facilities, technology development, and shared equipment)

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
Incinerator Ash	Calcine & Cement at Rocky Flats	3.6	110	38	2	150	41.3
Incinerator Ash	Vitrification at Rocky Flats	1.9	34	36	1	72	37.7
Incinerator Ash	Cold Ceramification at Rocky Flats	1.9	34	36	1	71	37.7
Incinerator Ash	Blend Down at Rocky Flats	2.5	52	43	1	95	38.3
Incinerator Ash	Fusion at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.5	8	4	1	13	27.2
Incinerator Ash	Fusion at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.5	8	4	1	13	27.2
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.4	6	4	1	11	28.0
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.4	6	4	1	11	28.0
Incinerator Ash	Calcine & Cement at Rocky Flats (Alternative 4)	3.6	110	38	2	150	41.3
Incinerator Ash	Repackage at Rocky Flats (Alternative 4)	1.3	4	37	1	42	33.5
Sand, slag & crucible	Calcine & Cement at Rocky Flats	0.6	16	8	0	24	40.1
Sand, slag & crucible	Vitrification at Rocky Flats	0.4	5	8	0	13	36.5
Sand, slag & crucible	Blend Down at Rocky Flats	0.5	7	9	0	17	37.0
Sand, slag & crucible	Repackage at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.1	1	1	0	2	22.8
Sand, slag & crucible	Repackage at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.1	1	1	0	2	22.8
Sand, slag & crucible	Calcine & Cement at Rocky Flats (Alternative 4)	0.5	16	2	0	18	40.1
Sand, slag & crucible	Repackage at Rocky Flats (Alternative 4)	0.2	1	7	0	8	34.2
Graphite Fines	Cement at Rocky Flats	0.2	7	2	0	10	41.3
Graphite Fines	Vitrification at Rocky Flats	0.1	3	2	0	5	38.4
Graphite Fines	Blend Down at Rocky Flats	0.2	3	3	0	6	38.5
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.0	0	0	0	1	27.4
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.0	0	0	0	1	27.4
Graphite Fines	Cement at Rocky Flats (Alternative 4)	0.2	7	2	0	10	41.3

		Years	Processing $M	Transuranic Waste $M	Low-Level Waste$M	Total $M	Total $M/yr
Graphite Fines	Repackage at Rocky Flats (Alternative 4)	0.1	0	2	0	3	33.8
Inorganic Ash	Calcine & Cement at Rocky Flats	0.3	6	5	0	12	38.6
Inorganic Ash	Vitrification at Rocky Flats	0.2	2	5	0	7	35.2
Inorganic Ash	Blend Down at Rocky Flats	0.3	3	6	0	9	35.6
Inorganic Ash	Calcine & Cement at Rocky Flats (Alternative 4)	0.3	6	5	0	12	38.6
Inorganic Ash	Repackage at Rocky Flats (Alternative 4)	0.2	0	5	0	6	32.9
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats	0.6	12	10	0	22	38.1
MSE/ER Salts (IDC 409)	Blend Down at Rocky Flats	1.0	30	10	0	40	41.2
MSE/ER Salts (IDC 409)	Distillation at Rocky Flats	0.2	7	1	0	8	40.3
MSE/ER Salts (IDC 409)	Water Leach at Rocky Flats	1.0	27	11	3	40	41.6
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats and Distillation at Los Alamos National Laboratory	0.1	5	1	0	6	42.5
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.2	6	1	0	8	42.0
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.2	6	1	0	8	42.0
MSE/ER Salts (IDC 409)	Pyro-oxidize, Blend, and Repackage at Rocky Flats (Alternative 4)	0.4	8	10	0	18	42.3
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats	1.5	28	29	1	57	37.8
MSE/ER Salts (All Others)	Blend Down at Rocky Flats	3.9	73	72	1	146	37.6
MSE/ER Salts (All Others)	Distillation at Rocky Flats	0.5	18	3	1	22	40.1
MSE/ER Salts (All Others)	Water Leach at Rocky Flats	4.1	65	80	19	164	39.9
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats and Distillation at Los Alamos National Laboratory	0.4	13	3	1	17	42.0
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.6	16	8	1	24	41.4
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.6	16	8	1	24	41.4
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats (Alternative 4)	1.5	27	29	1	56	37.7
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats	0.4	12	4	0	16	41.0
DOR Salts (IDCs 365, 413, 427)	Blend Down at Rocky Flats	0.5	18	5	0	22	41.7

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
DOR Salts (IDCs 365, 413, 427)	Water Leach at Rocky Flats	0.5	16	5	1	23	42.0
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	0.0	1	0	0	1	42.5
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	0.0	1	0	0	1	42.5
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.1	4	1	0	4	41.9
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.1	4	1	0	4	41.9
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize, Blend, and Repackage at Rocky Flats (Alternative 4)	0.3	4	6	0	10	36.8
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats	0.2	4	2	0	7	39.9
DOR Salts (All Others)	Blend Down at Rocky Flats	0.4	5	9	0	14	35.7
DOR Salts (All Others)	Water Leach at Rocky Flats	0.5	6	10	2	19	39.5
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	0.0	0	0	0	1	40.3
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	0.0	0	0	0	1	40.3
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.1	1	1	0	2	40.5
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.1	1	1	0	2	40.5
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats (Alternative 4)	0.2	4	2	0	7	39.9
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats	0.1	2	3	0	5	41.7
Aqueous-Contaminated Combustibles	Sonic Wash at Rocky Flats	0.1	2	1	0	3	39.7
Aqueous-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	0.3	7	4	1	12	41.2
Aqueous-Contaminated Combustibles	Blend Down at Rocky Flats	0.0	1	1	0	1	38.0
Aqueous-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	0.2	2	4	1	6	38.7

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats at Rocky Flats(Alternative 4)	0.1	2	3	0	5	41.7
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats	0.1	3	2	0	5	43.2
Organic-Contaminated Combustibles	Sonic Wash at Rocky Flats	0.1	2	1	0	2	40.0
Organic-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	0.2	5	3	0	8	42.8
Organic-Contaminated Combustibles	Blend Down at Rocky Flats	0.0	0	0	0	1	38.8
Organic-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	0.1	1	3	0	4	41.3
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats	0.1	3	2	0	5	43.2
Dry Combustibles	Repackage at Rocky Flats	0.0	0	2	0	2	40.3
Dry Combustibles	Sonic Wash at Rocky Flats	0.1	1	1	0	2	39.7
Dry Combustibles	Catalytic Chemical Oxidation at Rocky Flats	0.2	4	2	1	7	41.2
Dry Combustibles	Blend Down at Rocky Flats	0.0	0	0	0	1	38.0
Dry Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	0.1	1	2	1	4	38.8
Dry Combustibles	Repackage at Rocky Flats (Alternative 4)	0.0	0	2	0	2	40.3
Plutonium Fluorides	Acid Dissolution at Rocky Flats	0.4	13	3	1	17	43.5
Plutonium Fluorides	Blend Down at Rocky Flats	1.3	23	26	0	50	37.1
Plutonium Fluorides	Acid Dissolution at Rocky Flats	0.4	13	2	1	16	42.4
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.0	0	0	0	1	26.3
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.0	0	0	0	1	26.3
Ful Flo Filter Media	Neutralize/Dry at Rocky Flats	0.3	3	11	0	13	41.3
Ful Flo Filter Media	Blend Down at Rocky Flats	0.1	1	2	0	3	36.8
Ful Flo Filter Media	Sonic Wash at Rocky Flats	0.1	2	2	0	5	38.2
Ful Flo Filter Media	Mediated Electrochemical Oxidation at Rocky Flats	0.2	2	6	1	9	38.8
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats	0.8	13	23	0	35	42.0
HEPA Filters (IDC 338)	Vitrification at Rocky Flats	0.2	4	4	0	9	38.0

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
HEPA Filters (IDC 338)	Blend Down at Rocky Flats	0.2	5	4	0	9	38.9
HEPA Filters (IDC 338)	Sonic Wash at Rocky Flats	0.4	11	5	0	16	40.5
HEPA Filters (IDC 338)	Mediated Electrochemical Oxidation at Rocky Flats	0.6	8	12	3	23	39.6
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats (Alternative 4)	0.8	13	23	0	35	42.0
HEPA Filters (All Others)	Neutralize/Dry at Rocky Flats	0.0	0	1	0	1	41.5
HEPA Filters (All Others)	Vitrification at Rocky Flats	0.0	0	0	0	0	35.2
HEPA Filters (All Others)	Blend Down at Rocky Flats	0.0	0	0	0	1	39.2
HEPA Filters (All Others)	Sonic Wash at Rocky Flats	0.0	0	0	0	1	37.0
HEPA Filters (All Others)	Mediated Electrochemical Oxidation at Rocky Flats	0.0	0	1	0	1	38.5
HEPA Filters (All Others)	Blend and Repackage at Rocky Flats (Alternative 4)	0.0	0	1	0	1	41.5
Sludge (IDCs 089, 099, 332)	Filter/Dry at Rocky Flats	0.0	0	0	0	0	41.5
Sludge (IDCs 089, 099, 332)	Vitrification at Rocky Flats	0.0	0	0	0	0	40.9
Sludge (IDCs 089, 099, 332)	Blend Down at Rocky Flats	0.0	0	0	0	0	38.2
Sludge (IDCs 089, 099, 332)	Blend and Repackage at Rocky Flats (Alternative 4)	0.0	0	0	0	0	37.5
Sludge (All Others)	Filter/Dry at Rocky Flats	0.3	3	8	0	11	41.6
Sludge (All Others)	Vitrification at Rocky Flats	0.1	1	1	0	3	37.8
Sludge (All Others)	Blend Down at Rocky Flats	0.1	1	1	0	3	37.8
Sludge (All Others)	Acid Dissolution at Rocky Flats	0.5	14	4	1	19	42.7
Sludge (All Others)	Filter/Dry at Rocky Flats (Alternative 4)	0.3	3	8	0	11	41.6
Glass	Neutralize/Dry at Rocky Flats	0.0	0	0	0	0	41.6
Glass	Vitrification at Rocky Flats	0.0	0	0	0	0	37.5
Glass	Blend Down at Rocky Flats	0.0	0	0	0	1	37.9
Glass	Sonic Wash at Rocky Flats	0.0	1	0	0	1	39.9
Glass	Mediated Electrochemical Oxidation at Rocky Flats	0.0	0	1	0	2	39.2
Glass	Neutralize/Dry at Rocky Flats(Alternative 4)	0.0	0	0	0	0	41.6
Graphite	Repackage at Rocky Flats	0.2	1	5	0	6	34.8
Graphite	Cement at Rocky Flats	0.2	2	5	0	8	36.1
Graphite	Vitrification at Rocky Flats	0.2	4	4	0	8	37.5
Graphite	Blend Down at Rocky Flats	0.2	4	4	0	8	37.4
Graphite	Mediated Electrochemical Oxidation at Rocky Flats	0.6	8	14	3	25	39.5

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.1	1	1	0	1	25.1
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.1	1	1	0	1	25.1
Graphite	Repackage at Rocky Flats (Alternative 4)	0.2	1	5	0	6	34.8
Inorganics	Repackage at Rocky Flats	0.0	0	1	0	1	34.9
Inorganics	Vitrification at Rocky Flats	0.0	1	1	0	2	37.5
Inorganics	Blend Down at Rocky Flats	0.0	1	1	0	2	38.1
Inorganics	Mediated Electrochemical Oxidation at Rocky Flats	0.1	2	3	1	6	39.3
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.0	0	0	0	0	22.3
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.0	0	0	0	0	22.3
Inorganics	Repackage at Rocky Flats (Alternative 4)	0.0	0	1	0	1	34.9
Scrub Alloy	Repackage at Rocky Flats	0.1	0	2	0	3	40.5
Scrub Alloy	Calcine and Vitrification at Rocky Flats	1.5	41	19	0	60	40.1
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.0	0	0	0	1	27.2
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.0	0	0	0	1	27.2

4.18.1 The No Action Alternative at Rocky Flats

In the No Action Alternative, direct and indirect labor and waste-related spending at Rocky Flats is estimated at about $399 million. Of this sum, about $239 million is related to labor (including site overheads) and low-level waste processing. It would be incurred over a weighted average of about 6.2 years of processing, with a maximum duration at any single facility of 7.2 years.[1] The remaining $160 million is related to packaging and characterization of the stabilized residues and transuranic waste. It would be incurred over an unspecified period of years, with the minority of expenditures (e.g., packaging) taking place concurrent with processing and the majority of the expenditures (i.e., characterization) probably taking place towards the end of the interim storage period (i.e., 2010-2015). Interim storage would also generate an estimated $23 million per year in incremental costs to maintain the site to store the stabilized residues and transuranic waste. This post-closure expenditure for storage is purely incremental to DOE budgets and site spending. Although DOE has not developed schedules or spending profiles for these post-2006 programs at the otherwise shut-down site, the following inferences can be made:

- During the period of No Action processing (about 1998-2005), the incremental spending at Rocky Flats for processing and low-level waste management is likely to exceed existing site spending by no more than $10-15 million per year. Of the roughly $40 million per year in average allocable expenditures at the site for activities other than transuranic waste management ($239 million over six years), very roughly 2/3 would be attributable to expenditures and staffing at the site that would be the same (or similar) with or without the No Action processing activities. The discussion in Section 4.17.2 on labor multipliers addresses this issue.

- During the period of interim storage (about 2006-2015), the incremental spending at Rocky Flats for site maintenance and transuranic waste characterization and management would require incremental spending of as much as $40-45 million per year. This spending would consist of about $23 million per year for maintaining the otherwise shutdown site and about $15-20 million per year for characterization of the stabilized residues and transuranic waste for the eventual shipment offsite. For cost analysis, this offsite shipment is assumed to be to WIPP by 2015.

- Incremental spending of $15-20 million per year could be accelerated to the processing period (1998-2005) from the interim storage period if characterization of the stabilized residues were conducted during processing and packaging rather than during interim storage.

In terms of labor requirements at the site, the processing activities under the No Action Alternative may require a few hundred people for six or seven years. Characterization activities could also require 100-200 people over either the processing period or the interim storage period. It is uncertain how many of these employees would be net additions to the site staff since detailed budgets and program plans for No Action processing and deferred characterization have not been developed. It is likely that a mix of existing and new employees will be used and that incremental labor requirements could be in the range of a few hundred over the 6-7 year period. During the interim storage period, an additional few hundred people currently maintaining and operating the site would be retained for up to about nine years. These numbers compare to current site employment exceeding 5,000.[2]

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[1] Processing durations of 5.5 years at Building 707, Module A, 6.0 years at Building 707, Module E, and Building 371, Room 3701. Durations at other facilities are minor.

[2] Many large-scale activities are underway at Rocky Flats that have no bearing on the present EIS, for example, management and disposition of highly enriched uranium and plutonium solutions. It would thus be improper for the present EIS to discuss site activities, especially site closure, as if it were entirely a function of the completion

(continued...)

Potentially significant impacts could be generated in two ways: (1) the interim storage period and the deferred conduct of characterization activities would preserve site employment at a level of several hundred for up to nine years beyond the date when the site would otherwise be closed (2006), and (2) the interim storage period would prevent DOE from returning the site (or some large portion of the site) to alternative productive uses for the same nine years. The former effect would be to continue injecting $40-45 million or more into the local economy for up to nine years after the planned closure of the site. The latter effect would be to lose some unspecified value from failing to promptly return the site to alternative productive uses.

In the context of the Denver metropolitan area, the multiplied effect of these expenditures during the processing period would appear as a modest increase in employment and income over existing site operations. Incremental multiplied regional employment during the processing period would be as much as 400-500 people. Incremental multiplied regional income during the processing period could be as much as $40 million per year. During the interim storage period, the first effect of the No Action Alternative would be to preserve employment and income in the area at a higher level than at a shutdown site. Compared to a closed site, incremental multiplied employment and income could be as much as 750-1,000 people and incremental multiplied income could be $80-100 million. As a practical matter, these gains would appear as a continuation of site activity rather than as a new phase in site activity. On the other hand, deferring the return of the site to alternative productive uses could generate higher negative socioeconomic consequences than continuing to maintain the site for interim storage and transuranic characterization.

4.18.2 Other Management Approaches at Rocky Flats

Table 4-67 shows the estimated spending at the site for the eight strategic management approaches (excluding costs for (1) common facilities upgrades and technology development, neither of which is decisional in this EIS, and (2) itemized, shared equipment, which is decisional).[3] The table shows that compared to the No Action alternative (excluding costs for maintaining the stabilized residues onsite beyond 2006), the other strategic management approaches generate much less total spending at Rocky Flats. The following points are significant:

- The No Action processing technologies for ash residues are $100-200 million more expensive than any of the processing technologies in the other management approaches. The difference in ash processing alone explains most of the difference in costs and durations for the No Action Alternative and the other management approaches.

- The No Action Alternative is assumed to require transuranic waste characterization expenditures during the interim storage period. The other management approaches are assumed to require transuranic waste characterization expenditures during the processing period. This difference explains the higher cost per year between the No Action Alternative on the one hand and the other management approaches on the other hand.

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[2] (...continued)
of the residues management in the present EIS. It is material in a socioeconomic context to note that if the preferred alternative in the present EIS is selected in the Record of Decision, management of the plutonium residues and scrub alloy is not on the critical path for closure of the facility.

[3] The only strategic management approach for which including itemized, shared equipment would make a major difference in expenditures at Rocky Flats is the Maximum Plutonium Separation Management Approach. Mediated electrochemical oxidation equipment requires an expenditure of $30 million, a portion of which would take place in the region of influence. Several processing technologies require an expenditure of $4 million at Rocky Flats for distillation equipment. This expenditure has no socioeconomic significance. These issues are discussed in Section 4.17.1.

Table 4–67 Estimated Spending at Rocky Flats for the Strategic Management Approaches

	No Action	*Preferred*	*Minimum Time at Rocky Flats*	*Lowest Cost*	*All at Rocky Flats*	*Fewest at Rocky Flats*	*Maximum Plutonium Separation*	*No Plutonium Separation*
	207 beyond for closure	207	130	127	208	106	123	286
	6.2	3.9	1.6	2.2	3.1	2.0	2.7	4.7
	7.2	5.5	2.6	3.2	5.1	2.8	3.4	10.2

- The more material is shipped to the Savannah River Site or the Los Alamos National Laboratory for processing (e.g., Fewest Actions at Rocky Flats) the briefer the spending profile at Rocky Flats. The average spending per year is relatively fixed but the durations change.

- The greater the difference between the average site-wide processing duration and the maximum single facility duration, the lower the annual expenditures and the more diffuse the spending pattern. This is significant only in the No Plutonium Separation Management Alternative. Average spending is in the $50-60 million per year range in general.

From a socioeconomic perspective, the other management approaches differ from each other only in duration. Once a management approach is completed, spending declines markedly. This decline relates both to the completion of processing activities and (depending on activities outside the present EIS) the winding down of overall site activities. The net result, compared to the No Action Alternative, is the withdrawal from the local economy of several hundred direct jobs and a like number of indirect jobs starting after a few years and about two to three times the reduction in employment a few years after that. The multiplied reduction in income would be as much as $50 million after a few years and well over $100 million per year once closure of the site was underway. These values are in the range of 1/4 of one percent to 1/2 of one percent or more of the $20 billion annual economy of the region. Employment impacts in the over-2 million regional labor force is a slightly smaller percentage due to the high average labor compensation at the site. In the long-run, the potential gains to the region from a prompt return of the site or most of the site to alternative productive uses should more than offset the short-term income and employment losses.

4.18.3 Savannah River Site

The preferred management approach includes Purex processing at F-Canyon of sand, slag, and crucible residues, fluorides residues, and scrub alloy. Collectively, these materials would increase spending at the Savannah River Site by perhaps $15 million per year compared to the No Action Alternative. If the materials were processed at the Savannah River Site H-Canyon, spending would increase by about twice as much. If all the materials that could be shipped to the Savannah River Site were shipped there in the maximum labor cost configuration for the Savannah River Site, the incremental labor allocable to the Savannah River Site would be about $30 million per year over a longer period. The majority of these costs would be incurred for processing ash and salts. Costs for Purex processing at H-Canyon would be extended for several years longer.

Costs for mediated electrochemical oxidation at H-Canyon would be $20 million higher than at F-Canyon for a 2-year decontamination and decommissioning phase and then would be similar.

The addition of an incremental $15 million per year for some number of years, although not large, would be noticeable in the Savannah River Site regional economic area. The Savannah River Site accounts for about 7 percent of regional economic area employment, versus 3/10 of 1 percent for Rocky Flats. Assuming all of the incremental hires at the Savannah River Site were recruited from currently unemployed people in the 15-county regional economic area, the unemployment rate would decline by more than 1/10 of 1 percentage point. Income in the six-county region of influence would increase by more than 1/10 of 1 percent for each of the years in which the processing activities took place. The site, the regional economic area, and the region of influence could easily accommodate all of these income-related benefits since the increase would be only a small percentage of the reductions in jobs and income experienced in the area due to reductions in site staffing in the 1990s. The net effect would be one of restoring some of the economic and socioeconomic benefits associated with the site rather than adding new benefits in an otherwise stable area.

The one potentially important variation on the Savannah River Site impacts would be if shipments of Rocky Flats plutonium residues and scrub alloy were responsible for extending the operations at one of the canyons. This EIS assumes that the Rocky Flats plutonium residues and scrub alloy can be processed incrementally with other materials that make up the baseline canyon operations plan. If Rocky Flats plutonium residues and scrub alloy processing were responsible for extending canyon operations, then the extension of canyon operations would be fully charged to the Rocky Flats program. Canyon operations costs exceed $3.2 million per month. If the processing of Rocky Flats materials were also responsible for deferring the shutdown of a canyon, it would generate even higher costs for continued surveillance and maintenance. The socioeconomic impacts of extended canyon operations would be several times greater than in the maximum processing cases noted above. The duration would be much shorter, however. The regional socioeconomic impacts would be large and positive due to manpower requirements, but those effects would be brief.

4.18.4 Los Alamos National Laboratory

If salt distillation is selected as the processing technology for the other molten salt extraction and electrorefining salts, an estimated $115 million expenditure on equipment and vault upgrades will be required at the Los Alamos National Laboratory over a six- to eight-year period. Direct and indirect labor costs for this processing technology are in the range of $10 million over five years. Spread over a large number of years, these expenditures could inject $20 million per year into the local economy and generate at least as much in incremental multiplied income. Overall, several hundred jobs could be created. This amounts to several tenths of one percent of the labor force. It would also be beneficial in that the labor compensation at the Los Alamos National Laboratory is well above an otherwise low regional average and thus provides disproportionate secondary benefits. No other processing technology at the Los Alamos National Laboratory requires expenditures that could have any socioeconomic significance in the regional economic area.

4.19 MATERIALS, UTILITIES, AND ENERGY

Table 4-68 shows materials, utilities, and energy for each processing technology for Rocky Flats, the Savannah River Site, and the Los Alamos National Laboratory. At each site, the total consumption of materials, utilities, and energy is consistent with the overall requirements for other inputs and outputs, e.g., residue mass, labor, low-level waste, etc. Nitrogen usage excludes the nitrogen volume used in the nitrogen boxes

The cost for electricity in the most energy-intensive processing technology at any site (Purex processing of fused incinerator ash at the Savannah River Site H-Canyon) is in the $100,000 range. Among preferred

processing technologies, Purex processing of sand, slag, and crucible at the Savannah River Site F-Canyon generates the highest costs for materials, utilities, and energy. Even so, it requires only a few thousand dollars in electricity and a few hundred dollars in steam, water, and fuel. Total program costs for any of the strategic management approaches are in the range of a few thousand dollars (for the Preferred Alternative) to a few tens of thousands of dollars.

Table 4–68
Materials, Utilities, and Energy

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Incinerator Ash and Firebrick Fines								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	209	0	8,883	0	391	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	326	0	0	0	786	0	0	0
Cold Ceramify at Rocky Flats	20	0	6	7	0	0	0	0
Calcine and Blend Down at Rocky Flats	128	0	698	0	0	55	5,520	0
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	162	0	0	0	280	0	16,773	0
Purex at Savannah River Site (F-Canyon)	1,197	855	14,250	0	0	0	0	3,021
(H-Canyon)	4,731	3,420	57,000	0	0	0	0	11,970
Preprocess at Rocky Flats	130	0	0	0	225	0	13,478	0
Mediated Electrochemical Oxidation at Savannah River Site (F-Canyon and H-Canyon equal)	655	462	7,707	0	0	0	0	1,665
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	209	0	8,883	0	391	0	0	0
Repackage at Rocky Flats	**37**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Sand, Slag, and Crucible Residues								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	54	0	2,312	0	102	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	85	0	0	0	205	0	0	0
Calcine and Blend Down at Rocky Flats	33	0	182	0	0	14	1,437	0
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Purex at Savannah River Site (F-Canyon)	**152**	**113**	**1,715**	**0**	**0**	**0**	**0**	**774**
(H-Canyon)	**493**	**359**	**6,240**	**0**	**0**	**0**	**0**	**1,232**
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	54	0	2,312	0	102	0	0	0
Repackage at Rocky Flats	5	0	0	0	0	0	0	0

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Graphite Fines								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	13	0	568	0	25	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	21	0	0	0	50	0	0	0
Calcine and Blend Down at Rocky Flats	8	0	45	0	0	4	353	0
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	4	0	0	0	0	0	0	0
Mediated Electrochemical Oxidation at Savannah River (F-Canyon and H-Canyon equal)	42	30	493	0	0	0	0	106
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	13	0	568	0	25	0	0	0
Repackage at Rocky Flats	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inorganic Ash								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	22	0	914	0	40	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	33	0	0	0	81	0	0	0
Calcine and Blend Down at Rocky Flats	13	0	72	0	0	6	568	0
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	22	0	914	0	40	0	0	0
Repackage at Rocky Flats	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 409 Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	77	0	605	0	0	57	5,744	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	107	0	587	0	0	46	4,649	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Salt Distill at Rocky Flats	97	0	785	0	0	75	7,451	0
Pyro-Oxidize and Water Leach at Rocky Flats	83	28	2,596	4,290	0	41	8,829	0
Pyro-Oxidize at Rocky Flats	77	0	605	0	0	57	5,744	
Salt Distill at Los Alamos National Laboratory	25		817	1,255	0	11	0	0
Salt Scrub at Rocky Flats	95	0	785	0	0	74	7,451	0
Purex at Savannah River Site (F-Canyon)	26	19	320	0	0	0	0	134
(H-Canyon)	66	48	794	0	0	0	0	167
Alternative 4 (Combination)								
Repackage at Rocky Flats	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other Electrorefining and Molten Salt Extraction Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	187	0	1,468	0	0	140	13,935	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	261	0	1,425	0	0	113	11,280	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Salt Distill at Rocky Flats	235	0	1,904	0	0	181	18,079	0
Pyro-Oxidize and Water Leach at Rocky Flats	200	69	6,298	10,409	0	98	21,421	0
Pyro-Oxidize at Rocky Flats	187	0	1,468	0	0	140	13,935	0
Salt Distill at Los Alamos National Laboratory	61	0	1,983	3,045	0	0	0	0
Salt Scrub at Rocky Flats	229	0	1,904	0	0	181	18,079	0
Purex at Savannah River Site (F-Canyon)	201	197	2,440	0	0	0	0	1,025
(H-Canyon)	503	363	6,056	0	0	0	0	1,272
Alternative 4 (Combination)								
Repackage at Rocky Flats	**24**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 365, 413, and 427 Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	24	0	192	0	0	18	1,818	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	34	0	186	0	0	15	1,471	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Water Leach at Rocky Flats	36	9	822	1,358	0	13	2,794	0
Pyro-Oxidize at Rocky Flats	**24**	**0**	**192**	**0**	**0**	**18**	**1,818**	**0**
Acid Dissolve at Los Alamos National Laboratory	**58**	**0**	**2634**	**3,951**	**0**	**0**	**0**	**0**
Pyro-Oxidize at Rocky Flats	24	9	192	0	0	18	1,818	0
Water Leach at Los Alamos National Laboratory	12	0	630	1,358	0	0	976	0
Salt Scrub at Rocky Flats	30	0	248	0	0	23	2,359	0
Purex at Savannah River Site (F-Canyon)	10	7	121	0	0	0	0	51
(H-Canyon)	26	19	318	0	0	0	0	67
Alternative 4 (Combination)								
Repackage at Rocky Flats	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other Direct Oxide Reduction Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	9	0	70	0	0	7	667	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	13	0	68	0	0	5	540	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Water Leach at Rocky Flats	10	3	301	498	0	5	1,025	0
Pyro-Oxidize at Rocky Flats	9	0	70	0	0	7	667	0
Acid Dissolve at Los Alamos National Laboratory	22	0	966	1,449	0	0	0	0
Pyro-Oxidize at Rocky Flats	9	0	70	0	0	7	667	0
Water Leach at Los Alamos National Laboratory	1	3	231	498	0	0	358	0
Salt Scrub at Rocky Flats	11	0	91	0	0	9	865	0
Purex at Savannah River Site (F-Canyon)	20	15	239	0	0	0	0	100
(H-Canyon)	53	38	632	0	0	0	0	133
Alternative 4 (Combination)								
Repackage at Rocky Flats	2	0	0	0	0	0	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Combustible Residues								
Alternative 1 (No Action) [a] Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats	3	10	0	0	0	0	124	0
Alternative 2 (without Plutonium Separation) Sonic Wash at Rocky Flats	10	28	1,565	0	17	0	0	0
Catalytic Chemical Oxidation at Rocky Flats	40	76	3,407	27	0	0	11,981	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	14	21	1,755	11	0	0	1,248	0
Alternative 4 (Combination) **Neutralize & Dry/Desorb & Passivate/ Repackage at Rocky Flats**	**3**	**10**	**0**	**0**	**0**	**0**	**124**	**0**
Plutonium Fluoride Residues								
Alternative 1 (No Action) [a] Dissolve, Oxidize, and Store at Rocky Flats	61	16	1,224	8	0	0	6,629	0
Alternative 2 (without Plutonium Separation) Blend Down at Rocky Flats	35	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation) Acid Dissolve at Rocky Flats	61	16	1,224	8	0	0	6,629	0
Preprocess at Rocky Flats								
Purex at the Savannah River Site	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(F-Canyon)	**112**	**84**	**1,330**	**0**	**0**	**0**	**0**	**566**
(H-Canyon)	**332**	**242**	**4,200**	**0**	**0**	**0**	**0**	**846**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 331 Ful Flo Filter Media								
Alternative 1 (No Action) [a]								
Neutralize/Dry and Store at Rocky Flats	2	0	0	0	0	0	388	0
Alternative 2 (without Plutonium Separation)								
Blend Down at Rocky Flats	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Sonic Wash at Rocky Flats	8	20	1,088	0	13	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	10	15	1,319	8	0	0	939	0
IDC 338 High-Efficiency Particulate Air Filter Media								
Alternative 1 (No Action) [a]								
Neutralize/Dry and Store at Rocky Flats	4	0	0	0	0	0	887	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	25	0	0	0	0	0	0	0
Blend Down at Rocky Flats	6	0	0	0	0	0	0	0
Sonic Wash at Rocky Flats	17	45	2,486	0	29	0	2,881	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	23	35	3,016	18	0	0	2,148	0
Alternative 4 (Combination)								
Neutralize/Dry at Rocky Flats	**4**	**0**	**0**	**0**	**0**	**0**	**887**	**0**
Other High-Efficiency Particulate Air Filter Media								
Alternative 1 (No Action) [a]								
Neutralize/Dry and Store at Rocky Flats	0	0	0	0	0	0	23	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	0	0	0	0	0	0	0	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Sonic Wash at Rocky Flats	0	1	65	0	0	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	1	0	39	0	0	0	28	0
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Cubic Feet)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 089, 099 and 332 Sludge Residues								
Alternative 1 (No Action) [a] Filter/Dry and Store at Rocky Flats	0	0	0	0	0	0	26	0
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	0	0	0	0	0	0	0	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Alternative 4 (Combination) **Repackage at Rocky Flats**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other Sludge Residues								
Alternative 1 (No Action) [a] Filter/Dry and Store at Rocky Flats	4	0	0	0	0	0	708	0
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	11	0	0	0	0	0	0	0
Blend Down at Rocky Flats	1	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation) Dissolve and Oxidize at Rocky Flats	66	18	1,338	11	0	0	7,240	0
Alternative 4 (Combination) **Filter/Dry at Rocky Flats**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Glass Residues								
Alternative 1 (No Action) [a] Neutralize, Dry and Store at Rocky Flats	0	0	0	0	0	0	65	0
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats	2	0	0	0	0	0	0	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Sonic Wash at Rocky Flats	1	3	182	0	2	0	0	0
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	2	2	220	0	0	0	151	0
Alternative 4 (Combination) **Neutralize and Dry at Rocky Flats**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.
Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Graphite Residues								
Alternative 1 (No Action) [a]								
Repackage and Store at Rocky Flats	4	0	0	0	0	0	0	0
Alternative 2 (without Plutonium Separation)								
Cement at Rocky Flats	25	0	1,061	0	47	0	0	0
Vitrify at Rocky Flats	38	0	0	0	0	0	0	0
Blend Down at Rocky Flats	5	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	28	43	3,688	23	0	0	2,625	0
Preprocess at Rocky Flats								
Mediated Electrochemical Oxidation at	4	0	0	0	0	0	0	0
Savannah River Site (F- and H-Canyon equal)	125	91	1,440	0	0	0	0	314
Alternative 4 (Combination)								
Repackage at Rocky Flats	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inorganic Residues								
Alternative 1 (No Action) [a]								
Repackage and Store at Rocky Flats	0	0	0	0	0	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	7	0	0	0	0	0	0	0
Blend Down at Rocky Flats	1	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	5	8	705	4	0	0	501	0
Preprocess at Rocky Flats								
Mediated Electrochemical Oxidation at the								
Savannah River Site (F-Canyon and	1	0	0	0	0	0	0	0
H-Canyon equal)	31	23	350	0	0	0	0	79
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Scrub Alloy								
Alternative 1 (No Action) [a]								
Repackage and Store at Rocky Flats	2	0	0	0	0	0	0	0
Alternative 2 (without Plutonium Separation)	365	0	0	0	879	0	0	0
Calcine and Vitrify at Rocky Flats								
Alternative 3 (with Plutonium Separation)								
Repackage at Rocky Flats	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Purex at Savannah River Site (F-Canyon)	**60**	**43**	**720**	**0**	**0**	**0**	**0**	**302**
(H-Canyon)	**179**	**130**	**2,160**	**0**	**0**	**0**	**0**	**454**

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.
Note: The impacts of the preferred processing technologies are presented in bold type.

In dollar terms, the costs for the materials, utilities, and energy would be very small. The cost for electricity in the most energy-intensive processing at any site (Purex processing of fused ash at Savannah River Site's H-Canyon) is in the $100,000 range. No other process requires more than a small fraction of that figure for any material, utility, or energy. For example, the 7.8 megawatt hours of electricity required for water leach of direct oxide reduction salt reduction at Los Alamos National Laboratory would cost less than $500. The total program cost for materials, utilities, and energy is likely to be no more than a few hundred thousand dollars.

4.20 IMPACTS OF THE NO ACTION ALTERNATIVE

As discussed in Chapter 2 of this EIS, DOE has identified processing technologies for each category or subcategory of plutonium residue and scrub alloy under Alternative 1 (the No Action Alternative). The impacts of these no action processing technologies are presented for each material category and subcategory in Sections 4.2 through 4.11, with each section being devoted to one material category. The impacts of the No Action Alternative were calculated by aggregating the appropriate impacts from the sets of impacts in Sections 4.2 through 4.11. All the processes in the No Action Alternative would take place at Rocky Flats, so there would be no transportation impacts in this alternative.

4.20.1 Products and Wastes

The No Action Alternative would generate stabilized residues, transuranic waste, and low-level waste. This alternative would not generate high-level waste, separated plutonium, or saltstone. The estimated amounts of the solid plutonium-bearing products and wastes are presented and compared to the onsite storage capacities in **Table 4–69**. Most of the stabilized residues would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13. The largest amount of material would be stabilized residues, most of which would be placed in safe, secure storage at Rocky Flats for an assumed 20-year period of time. The transuranic waste would be placed in safe, secure storage at Rocky Flats until WIPP is ready to receive it. DOE would need new storage facilities at Rocky Flats for the stabilized residues.

Table 4–69 Products and Wastes from the No Action Alternative

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*Low-Level Waste (Drums)*[a]
Generation	20,300	3,500	7,500
Onsite Storage Capacity	13,400[b]	13,400[b]	21,800

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] This storage capacity is for both the stabilized residues and transuranic waste combined.

The low-level waste would probably be placed in standard 208-liter (55-gal) waste drums. The low-level waste would be disposed of in one of the offsite disposal facilities routinely used by Rocky Flats, so the onsite storage capacity would probably not be necessary.

4.20.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which might result from the No Action Alternative associated with the management of all Rocky Flats plutonium residues and scrub alloy. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. The detailed site analyses are presented in Appendix D.

No construction of new processing facilities is included in this alternative, but DOE may need to modify certain existing facilities and construct new waste storage buildings at Rocky Flats. Standard site mitigation measures

during any modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.20.2.1 Incident-Free Operations

Radiological Impacts—The radiological impacts to the public and the workers associated with incident-free implementation of the No Action Alternative are presented in **Table 4–70**. The impacts are those that are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of residues and scrub alloy. The post-processing storage of the stabilized residues and transuranic wastes would also produce impacts, but these are very small compared to the impacts due to processing.

The estimated total public maximally exposed individual dose is 0.00047 mrem, which applies to a hypothetical individual who lives downwind at the site boundary. This individual's chance of incurring a latent cancer fatality due to this alternative would be less than one in one billion.

Table 4–70 Radiological Impacts Due to Incident-Free Implementation of the No Action Alternative

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose[a] (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0.00047	2.4×10^{-10}	0.012	6.0×10^{-6}
Maximally Exposed Individual Involved Worker		*Involved Worker Population*	
Dose (mrem per year)	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
2,000	0.0008	1,204	0.48

[a] The doses to the maximally exposed individual for each material category are additive because the maximum receptor location was determined to be the same for every material, regardless of whether the release location is Building 371 or Building 707 at Rocky Flats. These two buildings are near each other.

The total public population radiation dose is 0.012 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would be approximately 1,204 person-rem, which would cause 0.48 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to very small incremental additional doses as discussed in Section 4.14.

Hazardous Chemical Impacts—The impacts of hazardous chemical releases associated with incident-free implementation of the No Action Alternative are presented in **Table 4–71**. Carbon tetrachloride is no longer used at Rocky Flats, but is present in small amounts in some of the residues. The probability of excess latent cancer incidence for the offsite maximally exposed individual as a result of exposure to carbon

tetrachloride would be 6×10^{-11}. This hypothetical individual's chance of incurring a latent cancer would be increased by less than one in ten billion.

Table 4–71 Chemical Impacts Due to Incident-Free Implementation of the No Action Alternative

Offsite Public Maximally Exposed Individual[a]		*Offsite Public Population*
Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences***
6×10^{-11}	0	<1[b]
Maximally Exposed Individual Worker		***Noninvolved Worker Population***
Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences***
3×10^{-9}	0	<1[c]

[a] Only carcinogenic chemicals are released from the process; therefore, only cancer health risks are evaluated. The Hazard Index is equal to zero.
[b] In a population of 2.4 million individuals living within 80 km (50 mi) of Rocky Flats.
[c] Based on the extremely conservative assumption that the entire Rocky Flats workforce of approximately 4,600 workers would be exposed to maximally exposed individual concentration.

Carbon tetrachloride is a carcinogen that produces toxic effects in the central nervous system, pulmonary system, gastrointestinal system, and other systems in humans (Sax and Lewis 1987). The compound is an eye and skin irritant and damages the liver, kidneys, and lungs (Lewis 1991). The liver is the primary target organ for carbon tetrachloride toxicity (EPA 1991a). Less than one latent cancer would be expected to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The maximally exposed individual worker probability of excess latent cancer incidence would be 3×10^{-9}. This hypothetical individual's risk of incurring a latent cancer would be increased by less than one chance in one hundred million. If all site workers were exposed to the maximally exposed individual concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than 1 excess latent cancer fatality would be expected to occur in the workforce population.

4.20.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents under the No Action Alternative are summarized and presented in this section. These impacts were derived directly from the sets of impacts for all the material categories presented in Sections 4.2 through 4.11. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3.

In any accident scenario the individuals most likely to be hurt are the involved workers. The risk to these workers would be due to both radiological and non-radiological effects. In a fire the involved workers could be exposed to airborne radioactive material, in addition to the smoke and heat of the fire. In an explosion, there could be flying debris and containment barriers could be broken, exposing workers to airborne radioactive material. Most spills would not have a major effect on involved workers because they would clean up the spill, wearing protective clothing and respirators as necessary. An accidental criticality could expose involved workers to large doses of prompt penetrating radiation, which could cause death in a short period of time. The earthquake and aircraft crash accident scenarios present very severe non-radiological effects to the involved workers. In these scenarios, the workers are likely to be hurt or killed from the collapse of the building or the impact of the aircraft crash before they could be evacuated.

The maximum number of involved workers at risk is estimated to be equal to the number of workers who would be working on plutonium residues or scrub alloy at any one time in each of the processing buildings at each

of the three sites. Buildings 707 and 371 at Rocky Flats would each have about 100 involved workers inside, which is more involved workers than any facility at either of the other two sites. Thus, if an earthquake strong enough to collapse Building 707 and damage Building 371 hits Rocky Flats, then approximately 200 involved workers would be at risk of death or injury due to activities associated with plutonium residues and scrub alloy.

The maximum consequences for the public and a noninvolved onsite worker if DOE decides to implement the No Action Alternative are presented in **Table 4–72**. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequences to all three receptors would occur if a major earthquake strong enough to cause the collapse of Building 707 occurs during pyro-oxidation of the salt residues. The frequency of this earthquake is estimated to be 0.0026 per year.

Table 4–72 Maximum Accident Consequences in the No Action Alternative

Residue, Processing Technology, and Location	*Accident Frequency (per year)*	*Offsite Public Maximally Exposed Individual Consequences*		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
		Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Salt Residues, Pyro-Oxidation at Rocky Flats	0.0026	6,080	0.0030	106,000	53	68,400	0.055

Differences exist between the Rocky Flats Cumulative Impacts Document (DOE 1997) for the 1996 Baseline and this EIS in terms of the maximum accident consequences. Several factors are responsible for the differences between the two documents, and are provided below in approximate order of importance.

1. The Cumulative Impacts Document used the median value for weather conditions and this EIS uses the 95th percentile. For the earthquake accident scenario, the 95th percentile yields a calculated value of 293,000 person-rem for the population and the 50th percentile yields a calculated value of 7,000 person-rem for the population.

2. The Cumulative Impacts Document used the MACCS computer code (also used for the other Rocky Flats EISs) and this EIS uses the GENII computer code.

3. The Cumulative Impacts Document used the actual material known to be in each building, and calculated the amount of dispersible material based upon conversion of plutonium metal to oxides, amount of oxides present, amount of residues present (with associated americium amounts) and amount of transuranic and low level waste present. This EIS used a much simpler approach, in that it used two IDCs, 409 and 410, both molten salt extraction salts containing the maximum quantity of americium, as the worst case scenario, and assumed a 5-day supply to be present in Building 707 upon collapse from an earthquake.

The approach taken in this EIS does not affect the validity of the Finding of No Significant Impact decision of the Residue Stabilization Environmental Assessment, because this EIS uses the worst case approach instead of the median approach.

The aggregation of all the risks due to accidents in the No Action Alternative to the public and a noninvolved onsite worker are presented in **Table 4–73**. The increase in the probability of a latent cancer fatality to the

public maximally exposed individual is estimated to be 0.000035. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The increase in latent cancer fatalities in the public population within 80 km (50 mi) of Rocky Flats is estimated to be 0.62, less than one latent cancer fatality. The increase in the probability of a latent cancer fatality to the noninvolved onsite worker is estimated to be 0.00061. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand. More than 95 percent of the latent cancer fatality accident risks for the No Action Alternative are attributable to the salt residues.

Table 4–73 Risks Due to Accidents in the No Action Alternative

Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Onsite Noninvolved Worker Risk (Probability of a Latent Cancer Fatality)*
0.000035	0.62	0.00061

4.20.2.3 Mitigation Measures

All the environmental impacts in the No Action Alternative would be low, and specific mitigation measures would not be necessary. Nevertheless, DOE would maintain all public and worker exposures, both direct exposures and indirect exposures via airborne emissions, as low as reasonably achievable. As low as reasonably achievable is a long-standing DOE policy to control or manage radiation exposures and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. As low as reasonably achievable is not a dose limit but rather a process that has as its objective the attainment of dose levels as far below the applicable limits as practical.

4.21 IMPACTS OF THE PREFERRED ALTERNATIVE

As discussed in Chapter 2, DOE has identified a variety of processing technologies for each category or subcategory of plutonium residue and scrub alloy. The impacts of all the processing technologies for each material category and subcategory are presented in Sections 4.2 through 4.11, with each section being devoted to one material category. The impacts of the Preferred Alternative were calculated by aggregating the preferred processing technology impacts from Sections 4.2 through 4.11. Some processes in the Preferred Alternative would take place at sites other than Rocky Flats, so transportation impacts would exist in this alternative.

4.21.1 Products and Wastes

The Preferred Alternative would generate high-level waste, transuranic waste, saltstone, low-level waste, and separated plutonium in the form of a metal and/or an oxide. The estimated amounts of the solid plutonium-bearing products and wastes are presented and compared to the onsite storage capacities in **Table 4–74**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The stabilized residues would not meet the safeguards termination limits, but DOE would apply variances to these limits for these residues. Thus, DOE would dispose of these stabilized residues in WIPP along with the transuranic waste with plutonium concentrations below the safeguards termination limits. Assuming WIPP opens on schedule, the transuranic waste storage capacity at Rocky Flats will be adequate in the Preferred Alternative for the transuranic wastes and stabilized residues combined. Under the Preferred Alternative, DOE would generate about 21,600 drums of stabilized residues and transuranic waste for disposal in WIPP.

The low-level waste would probably be placed in standard 208-liter (55-gal) waste drums. The low-level waste at Rocky Flats would be disposed of in one of the offsite disposal facilities routinely used by Rocky Flats. The

Savannah River Site and Los Alamos National Laboratory would use their onsite low-level waste disposal facilities. The plutonium would be ready for disposition in accordance with decisions to be reached on the *Surplus Plutonium Disposition Draft EIS* (DOE 1998b). The plutonium separated at the Savannah River Site would be stored securely in the Actinide Packaging and Storage Facility. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. The high-level waste would be stored at the Savannah River Site until a monitored geologic repository is ready to receive it. The saltstone would be disposed of at the Savannah River Site in concrete vaults.

Table 4–74 Products and Wastes from the Preferred Alternative

DOE Site	*Stabilized Residues[a] (Drums)[b]*	*Transuranic Waste (Drums)[b]*	*High-Level Waste (Canisters of Glass)[c]*	*Separated Plutonium (kg)[d]*	*Low-Level Waste (Drums)[b]*	*Saltstone (cubic meters)*
Rocky Flats Generation	18,400	2,300	0	0	4,400	0
Onsite Storage Capacity	13,400[e]	13,400[e]	0	12,900[f]	21,800	0
Savannah River Site Generation	0	50	5	469	200	500
Onsite Storage Capacity	0	74,600	2,286	20,000[g]	(h)	(h)
Los Alamos National Laboratory Generation	0	800	0	138	1,800	0
Onsite Storage Capacity	0	116,900	0	2,700[i]	(h)	0

[a] These stabilized residues could be disposed of in WIPP as transuranic waste.
[b] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[c] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[d] To convert to pounds, multiply by 2.2
[e] This storage capacity is for both the stabilized residues and transuranic waste combined.
[f] This is the amount of plutonium that was stored at Rocky Flats as of September 1994. DOE has analyzed the shipment of the plutonium to the Savannah River Site and the Pantex Plant in the Storage and Disposition of Weapons-Usable Fissile Materials Environmental Impact Statement (DOE 1996a).
[g] The new Actinide Packaging and Storage Facility is being designed with positions for 5,000 storage containers (DOE 1997d). Each container holds at least 4 kg of plutonium, so the capacity of the Actinide Packaging and Storage Facility will be at least 20,000 kg of plutonium.
[h] The site routinely disposes of this waste onsite.
[i] This is the amount of plutonium that was stored at the Los Alamos National Laboratory as of September 1994 (DOE 1996a).

4.21.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the Preferred Alternative associated with the management of all Rocky Flats plutonium residues and scrub alloy. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

If DOE decides to implement the Preferred Alternative, then DOE would make 39 shipments to the Savannah River Site and 3 shipments to the Los Alamos National Laboratory. The total round-trip highway distance would be about 208,000 kilometers (129,000 miles).

No construction of new processing facilities is included in this alternative but DOE may need to modify certain existing facilities and construct new waste storage buildings if shipments to WIPP are delayed. Standard mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.21.2.1 Incident-Free Operations

Radiological Impacts—The radiological impacts to the public and the workers associated with incident-free implementation of the Preferred Alternative are presented in **Table 4–75**. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of plutonium residues and scrub alloy.

The length of time necessary to process all the material will depend on which technologies DOE decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce impacts, but these are very small compared to the impacts due to processing.

Table 4–75 Radiological Impacts Due to Incident-Free Implementation of the Preferred Alternative

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
11	5.5×10^{-6}	4.0	0.0020
Maximally Exposed Individual Worker		***Noninvolved Worker Population***	
Dose (mrem per year)	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
2,000	0.00080	682	0.27

The estimated total public maximally exposed individual dose, as shown in Table 4–75, is 11 mrem, which applies to a hypothetical member of the public stuck in traffic next to a safe secure trailer for one-half hour. See discussion in Section 4.2.2.1 regarding the conservative nature of this analysis. This individual's chance of incurring a latent cancer fatality due to this alternative would be 5.5×10^{-6}, or less than one chance in one hundred thousand. The public maximally exposed individual near any of the sites would be a hypothetical individual who lives downwind at the site boundary. The highest estimated total dose for this maximally exposed individual would be 0.00057 mrem at the Savannah River Site. This individual's chance of incurring a latent cancer fatality due to this alternative would be less than one in one billion.

The total public population radiation dose, as shown in Table 4–75, would be 4.0 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero. The highest public population radiation dose (excluding transportation) was determined to be 0.062 person-rem to the population surrounding the Savannah River Site, which would cause far less than one additional latent cancer fatality to this population. During incident-free storage, there would be no release of radioactive material, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would be 682 person-rem, which would cause 0.27 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facilities would expose the involved worker population to very small incremental additional doses, as discussed in Section 4.14.

Hazardous Chemical Impacts—The impacts of hazardous chemical releases associated with incident-free processing under the Preferred Alternative are presented in **Table 4–76**. The probability of excess latent cancer incidence for the offsite maximally exposed individual would be 6×10^{-11}. This hypothethical

individual's chance of incurring a latent cancer would be increased by less than one in ten billion. Less than one latent cancer would be expected to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The maximally exposed individual worker probability of excess latent cancer incidence would be 3×10^{-9}. This hypothetical individual's risk of incurring a latent cancer would be increased by less than one chance in one hundred million. If all site workers were exposed to the maximally exposed individual concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than one excess latent cancer fatality would be expected to occur in the workforce population. The Hazard Index value of 5×10^{-9} suggests that noncancer adverse health effects are not expected in the offsite population at the Savannah River Site following exposure to phosphoric acid and ammonium nitrate. The Hazard Index value of 6×10^{-8} suggests that noncancer adverse health effects are not expected in the worker population.

Table 4–76 Chemical Impacts Due to Incident-Free Implementation of the Preferred Alternative

Offsite Public Maximally Exposed Individual		*Offsite Public Population*[a]	
Probability of Cancer Incidence	***Hazard Index***[b]	***Number of Cancer Incidences***	***Number of Latent Cancer Fatalities***
6×10^{-11}	5×10^{-9}	< 1	0.00052[c]
Maximally Exposed Individual Worker		***Noninvolved Worker Population***	
Probability of Cancer Incidence	***Hazard Index***[b]	***Number of Cancer Incidences***	***Number of Latent Cancer Fatalities***
3×10^{-9}	6×10^{-8}	< 1	(c)

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.
[b] Highest value for materials processed at the Savannah River Site under this alternative.
[c] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

The impacts of vehicle emissions associated with incident-free transportation under the Preferred Alternative are also presented in Table 4–76. The health effect due to these vehicle emissions would be 0.00062 latent cancer fatalities. This is much less than one, so DOE would not expect any latent cancer fatalities due to the vehicle emissions.

4.21.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents under the Preferred Alternative are summarized and presented in this section. These impacts were derived directly from the sets of impacts for all the material categories presented in Sections 4.2 through 4.11. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

In any accident scenario the individuals most likely to be hurt are the involved workers. The risk to these workers would be due to both radiological and non-radiological effects. In a fire the involved workers could be exposed to airborne radioactive material, in addition to the smoke and heat of the fire. In an explosion, there could be flying debris and containment barriers could be broken, exposing workers to airborne radioactive material. Most spills would not have a major effect on involved workers because they would clean up the spill,

wearing protective clothing and respirators as necessary. An accidental criticality could expose involved workers to large doses of prompt penetrating radiation, which could cause death in a short period of time. The earthquake and aircraft crash accident scenarios present very severe non-radiological effects to the involved workers. In these scenarios, the workers are likely to be hurt or killed from the collapse of the building or the impact of the aircraft crash before they could be evacuated.

The maximum number of involved workers at risk is estimated to be equal to the number of workers who would be working on plutonium residues or scrub alloy at any one time in each of the processing buildings at each of the three sites. Buildings 707 and 371 at Rocky Flats would each have about 100 involved workers inside, which is more involved workers than any facility at either of the other two sites. Thus, if an earthquake strong enough to collapse Building 707 and damage Building 371 hits Rocky Flats, then approximately 200 involved workers would be at risk of death or injury due to activities associated with plutonium residues and scrub alloy.

The maximum consequences for the public and a noninvolved onsite worker if DOE decides to implement the Preferred Alternative, are presented in **Table 4–77**. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequence to all three receptors would occur if a major earthquake strong enough to collapse Building 707 occurs during the repackaging of high-assay salt residues at Rocky Flats.

Table 4–77 Maximum Accident Consequences in the Preferred Alternative

Residue, Processing Technology, and Location	*Accident Frequency (per year)*	*Offsite Public Maximally Exposed Individual Consequences*		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
		Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Salt Residues							
Repackage at Rocky Flats	0.0026	20,300	0.020	356,000	178	229,000	0.18

The aggregation of all the risks due to accidents in the Preferred Alternative to the public and an onsite worker are presented in **Table 4–78**. The increase in the probability of a latent cancer fatality to the public maximally exposed individual is estimated to be 0.000038. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The offsite public population risk is the summation of the risks due to radiological releases at the three sites, radiological releases along the transportation routes, and traffic fatalities. The total public population risk for the Preferred Alternative would be 0.64 latent cancer or traffic fatalities. The increase in the probability of a latent cancer fatality to the noninvolved onsite worker is estimated to be 0.00070. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand. More than 80 percent of the latent cancer fatality accident risks for the Preferred Alternative are attributable to the salt residues.

Table 4–78 Risks Due to Accidents in the Preferred Alternative

Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
0.000038	0.64	0.00070

4.21.2.3 Mitigation Measures

All the environmental impacts in the Preferred Alternative would be low and within regulatory limits, so specific mitigation measures would not be necessary. Nevertheless, DOE would maintain all public and worker exposures, both direct exposures and indirect exposures via airborne emissions, as low as reasonably achievable. As low as reasonably achievable is a long-standing DOE policy to control or manage radiation exposures and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. As low as reasonably achievable is not a dose limit but rather a process that has as its objective the attainment of dose levels as far below the applicable limits as practical.

4.22 COMPARISON OF THE IMPACTS OF THE STRATEGIC MANAGEMENT APPROACHES

As discussed in Chapter 2, Section 2.5, eight Strategic Management Approaches have been constructed by selecting a processing technology for each of the 19 material categories and/or subcategories. The primary impacts of the eight Strategic Management Approaches are presented in **Table 4-79**. These impacts have been derived from the impacts presented for each material category in Sections 4.2 through 4.11. Seven of the Strategic Management Approaches would satisfy United States nonproliferation policy. Only the No-Action Alternative would allow nuclear nonproliferation concerns to continue.

4.22.1 Products and Wastes

The amounts of primary solid plutonium-bearing products and wastes that would be generated under the Strategic Management Approaches are compared in **Figures 4-1** through **4-5**.

For each Strategic Management Approach, except for No Action, the quantity of waste that could be sent to WIPP for disposal as transuranic waste is the sum of the quantities of drums shown in Figures 4-1 and 4-2. Under the Preferred Alternative, DOE would generate about 21,600 drums of processed residues and secondary waste that would be sent to WIPP for disposal. Under the No Action alternative, no processed residues would be disposed of.

The processed residues and secondary transuranic wastes that would be generated under the alternatives in this EIS are broken down into the two groupings shown in Figures 4-1 and 4-2 to distinguish between processed materials that would be below the safeguards termination limits and could thus be sent to WIPP, and those materials that would be above the safeguards termination limits and could only be sent to WIPP under a variance to safeguards termination limits:

- The term "Stabilized Residues," as used in the title of Figure 4-1, refers to processed materials that would still be above the safeguards termination limits even after processing under the action alternatives. The "stabilized residues" produced under the No Action alternative would be stored onsite and would not be sent to WIPP for disposal because their plutonium content would exceed the safeguards termination limits. The other "stabilized residues" that could be produced under this EIS

would result from Alternative 4 and would be subject to a variance. As a result, they could be disposed of in WIPP.

- The term "Transuranic Waste," as used in the title of Figure 4-2, refers to those materials that would be below the safeguards termination limits after processing under the alternatives of this EIS. It includes both the processed residues and secondary transuranic waste that would be produced during the processing operation.

To reiterate, for the action alternatives of this EIS, the quantities in Figures 4-1 and 4-2 must be summed to determine the amount of transuranic waste that could be sent to WIPP.

Figure 4-4 shows the amounts of plutonium that could be separated from the plutonium residues and scrub alloy. Two of the management approaches (No Action and Process without Plutonium Separation) do not involve any plutonium separation. Under the Preferred Alternative, DOE would separate roughly one-quarter of the plutonium that could be separated under the Maximum Plutonium Separation Management Approach. If any plutonium is separated, it would be placed in safe, secure storage until DOE makes decisions on its disposal or other disposition. DOE would not use this plutonium for nuclear explosive purposes.

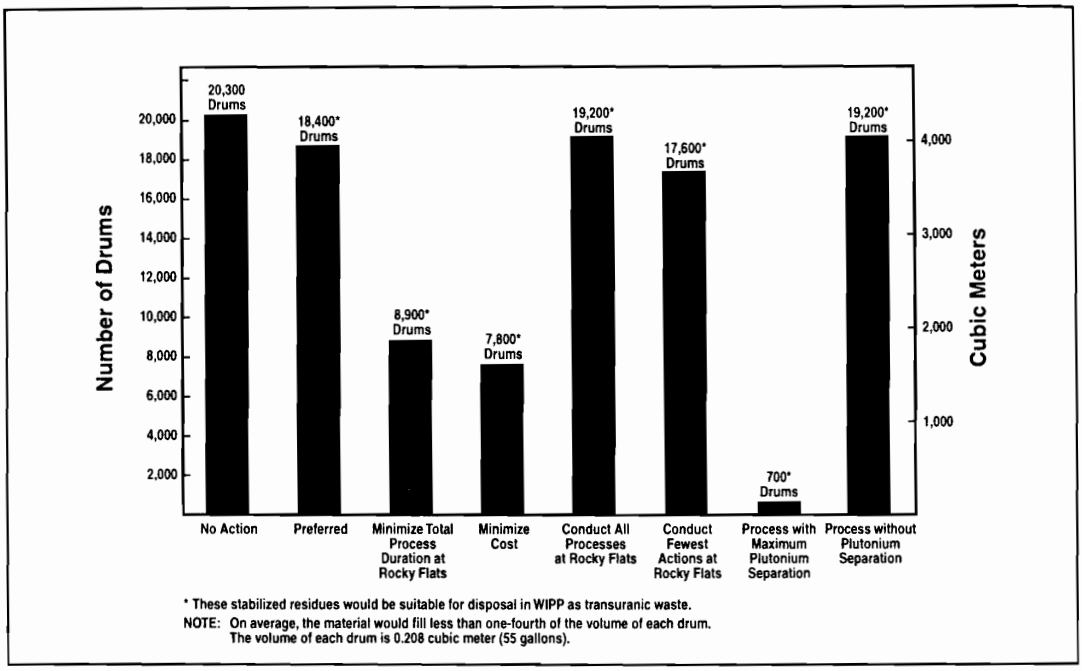
Table 4–79 Impacts of the Strategic Management Approaches

Impact	*Strategic Management Approaches*							
	No Action	***Preferred***	***Minimize Total Process Duration at Rocky Flats***	***Minimize Cost***	***Conduct all Processes at Rocky Flats***	***Conduct Fewest Actions at Rocky Flats***	***Process with Maximum Plutonium Separation***	***Process without Plutonium Separation***
Products and Wastes								
Stabilized Residues (drums) [a]	20,300	**18,400** [b]	8,900 [b]	7,800 [b]	19,200 [b]	17,600 [b]	700 [b]	19,200 [b]
Transuranic Waste (drums) [a, c]	3,500	**3,200**	6,600	3,400	5,600	3,200	9,300	9,200
High-Level Waste (canisters) [d]	0	**5**	2	1	0	5	42	0
Separated Plutonium (kilograms) [e]	0	**607**	1,082	1,279	141	607	2,709	0
Low-Level Waste (drums) [a]	7,500	**6,400**	10,400	4,900	5,500	6,400	19,900	4,800
Radiological Public and Occupational Health and Safety								
Incident-Free Radiological Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	2.4×10^{-10}	**5.5×10^{-6}**	5.5×10^{-6}	5.5×10^{-6}	1.2×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	9.4×10^{-11}
Incident-Free Radiological Risk to the Public Population (Latent Cancer Fatalities)	6.0×10^{-6}	**0.0020**	0.0016	0.00083	4.0×10^{-6}	0.0020	0.0079	3.5×10^{-6}
Incident-Free Radiological Risk to the Maximally Exposed Individual Worker (Probability of a Latent Cancer Fatality per year)	0.0008	**0.0008**	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
Incident-Free Radiological Risk to the Worker Population (Latent Cancer Fatalities)	0.48	**0.27**	0.25	0.24	0.28	0.27	0.34	0.40
Worker Hazard Index	<<1	**<<1**	<<1	<<1	<<1	<<1	<<1	<<1
Accident Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	0.000035	**0.000038**	0.000032	0.000035	0.000036	0.000038	0.000046	0.000036
Accident Risk to the Public Population (Latent Cancer or Traffic Fatalities)	0.62	**0.64**	0.53	0.62	0.64	0.64	0.67	0.65
Accident Risk to the Noninvolved Onsite Worker (Probability of a Latent Cancer Fatality)	0.00061	**0.00070**	0.00062	0.00065	0.00067	0.00070	0.00085	0.00067

Impact	*Strategic Management Approaches*							
	No Action	***Preferred***	***Minimize Total Process Duration at Rocky Flats***	***Minimize Cost***	***Conduct all Processes at Rocky Flats***	***Conduct Fewest Actions at Rocky Flats***	***Process with Maximum Plutonium Separation***	***Process without Plutonium Separation***
Other Impacts								
Intersite Round-Trip Transportation (1,000 kilometers) [f]	0	**208**	166	84	0	208	823	0
Cost (million $) [f, g, h]	1,129 [i,j]	**524** [k]	482 [j,l,m]	428 [k]	510 [j]	668 [j]	814 [p]	539 [k]
Processing Duration at Rocky Flats (years) [q]	7.2	**5.5** [m,n]	2.6 [l,m]	3.2 [m]	5.1	2.8 [m,o]	3.4 [l,m]	10.2
Air Quality Impacts	no exceedances (See Sections 4.12 and 4.25)	**no exceedances (See Sections 4.12 and 4.25)**	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)
Nuclear Nonproliferation Considerations	(r)	**(s)**	(s)	(s)	(s)	(s)	(s)	(s)

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Transuranic waste includes secondary waste, such as disposable clothing and contaminated laboratory equipment.
[d] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680) kg) of high-level waste glass.
[e] To convert to pounds, multiply by 2.2.
[f] To convert thousands of kilometers to thousands of miles, multiply by 0.62.
[g] Decisional costs for labor, site overheads, itemized equipment, residue and waste processing, waste shipment and disposal, and fissile materials disposition, plus non-decisional costs for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work. Excludes adjustments for technical or schedule uncertainties.
[h] Undiscounted 1997 dollars.
[i] Includes $460 million for 20 years of interim storage at Rocky Flats.
[j] Includes $220 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.
[k] Includes $190 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.
[l] Processing duration at Los Alamos Nuclear Laboratory is about six months.
[m] Includes processes at Savannah River Site F-Canyon. Processing durations at the Savannah River Site depend on schedules for materials in programs outside the scope of this EIS.
[n] Processing duration at Los Alamos Nuclear Laboratory is about four months.
[o] Processing duration at Los Alamos Nuclear Laboratory depends on the type of new salt distillation equipment and the timing of its installation. The duration therefore depends on schedules for materials in programs outside the scope of this EIS.
[p] Includes $250 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.
[q] Sum of durations for processing technologies with the shortest individual processing time at Rocky Flats. All processes at different buildings or modules at Rocky Flats are conducted concurrently. The sum of the shortest individual processing times does not necessarily equal the shortest processing time at the site since longer duration processing technologies at one facility may shorten the total duration at the site. Processing duration does not reflect technical or schedule uncertainties, deferred start-up due to technology demonstration and testing, or schedule interactions among processing technologies, facilities, or sites.
[r] The plutonium residues and scrub alloy would be left in forms that cannot be disposed of due to nuclear nonproliferation considerations.

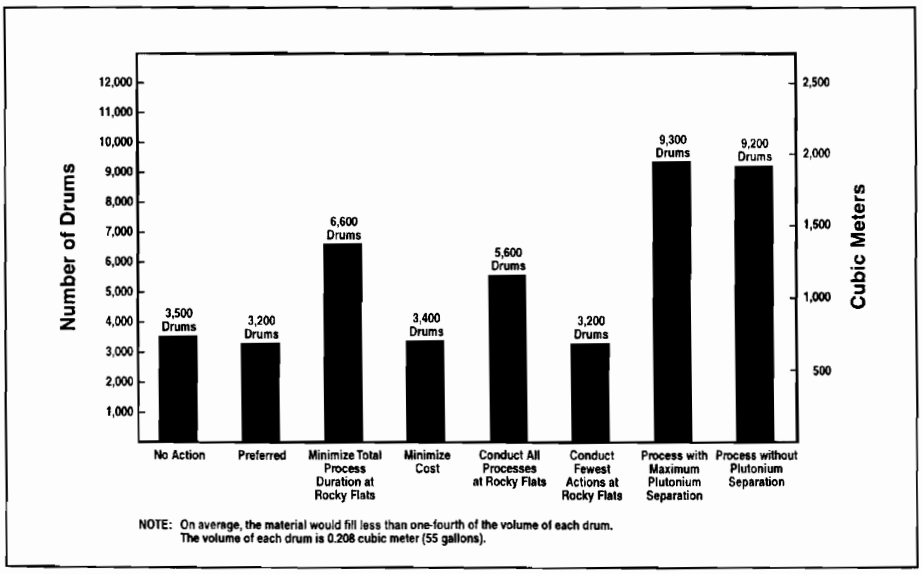
[s] The plutonium residues and scrub alloy would be managed and placed in forms that can be disposed of or dispositioned in a manner that supports United States nuclear weapons nonproliferation policy.



* These stabilized residues would be suitable for disposal in WIPP as transuranic waste.

NOTE: On average, the material would fill less than one-fourth of the volume of each drum. The volume of each drum is 0.208 cubic meter (55 gallons).

Figure 4–1 Stabilized Residues Generated Under Each Strategic Management Approach



NOTE: On average, the material would fill less than one-fourth of the volume of each drum. The volume of each drum is 0.208 cubic meter (55 gallons).

Figure 4–2 Transuranic Waste Generated Under Each Strategic Management Approach

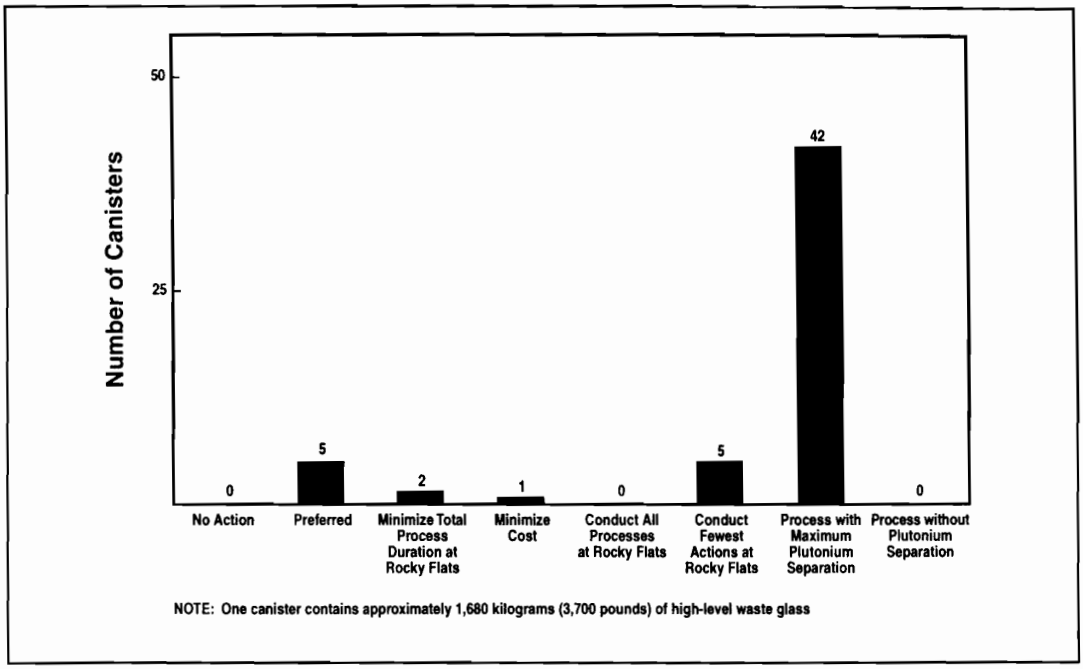


Figure 4–3 High-Level Waste Generated Under Each Strategic Management Approach

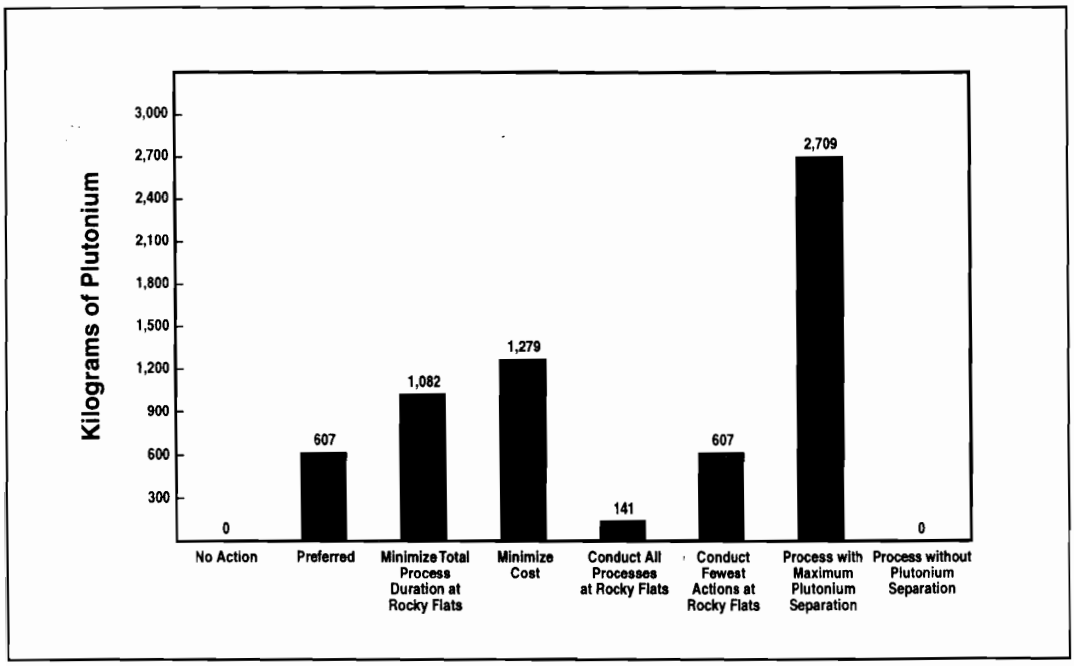


Figure 4–4 Plutonium Separated Under Each Strategic Management Approach

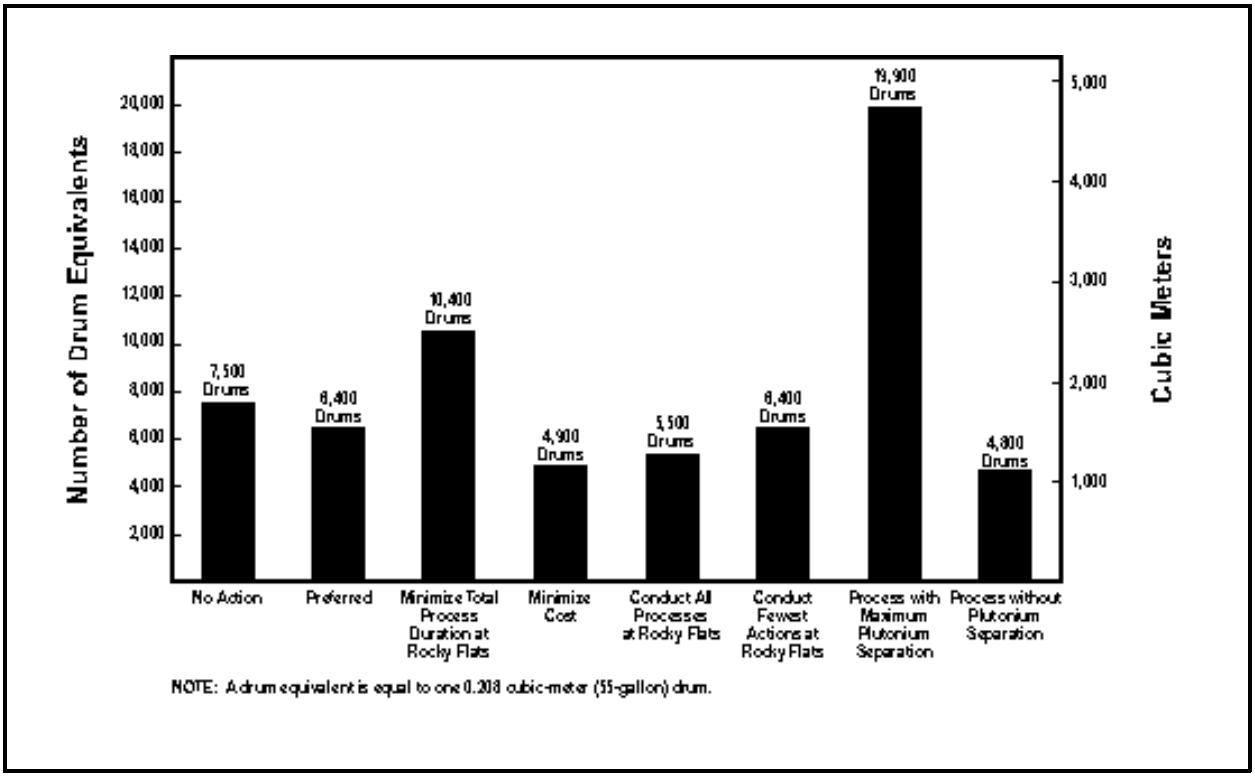


Figure 4–5 Low-Level Waste Generated Under Each Strategic Management Approach

The amounts of material to be managed as high-level waste and of low-level radioactive wastes that would be generated under each management approach are shown in Figures 4-3 and 4-5. The Process with Maximum Plutonium Separation Management Approach would generate the most material to be managed as high-level waste and also the most low-level waste. The Preferred Alternative would generate significantly smaller quantities of these wastes than this approach.

4.22.2 Public and Occupational Health and Safety Impacts

All of the Stratgic Management Approaches present low risks to the public and to workers. DOE estimates less than one additional latent cancer fatality to occur in the general public as a result of radiation exposure, no matter which Strategic Management Approach is selected. Nevertheless, differences exist between the risks presented by the eight Strategic Management Approaches. **Figures 4–6** through **4-12** display the risk comparisons for the public and workers under both incident-free and accident conditions.

As shown in Figure 4–6, the Strategic Management Approaches with intersite transportation would involve greater risk to the public maximally exposed individual than those without intersite transportation. A conservative upper-bound estimate of the chance that this hypothetical individual would incur a latent cancer fatality would be about 5.5×10^{-6}, or less than one chance in one hundred thousand. As shown in Figure 4–7, one Strategic Management Approach presents a risk of about 0.0079 additional latent cancer fatalities, while the Preferred Alternative presents a risk of only 0.0020 additional latent cancer fatalities. In all cases the estimated risks are so low that no member of the public would be likely to incur a latent cancer fatality due to incident-free operations.

As shown in Figure 4–8, all the Strategic Management Approaches are equal in terms of the annual risk to the maximally exposed individual involved worker. This is because DOE applied the same conservative

assumption across the board for this part of the analysis. This assumption is the DOE Administrative Control level of 2,000 mrem per year. Most of the risk comparisons in this EIS are based on the total amounts of

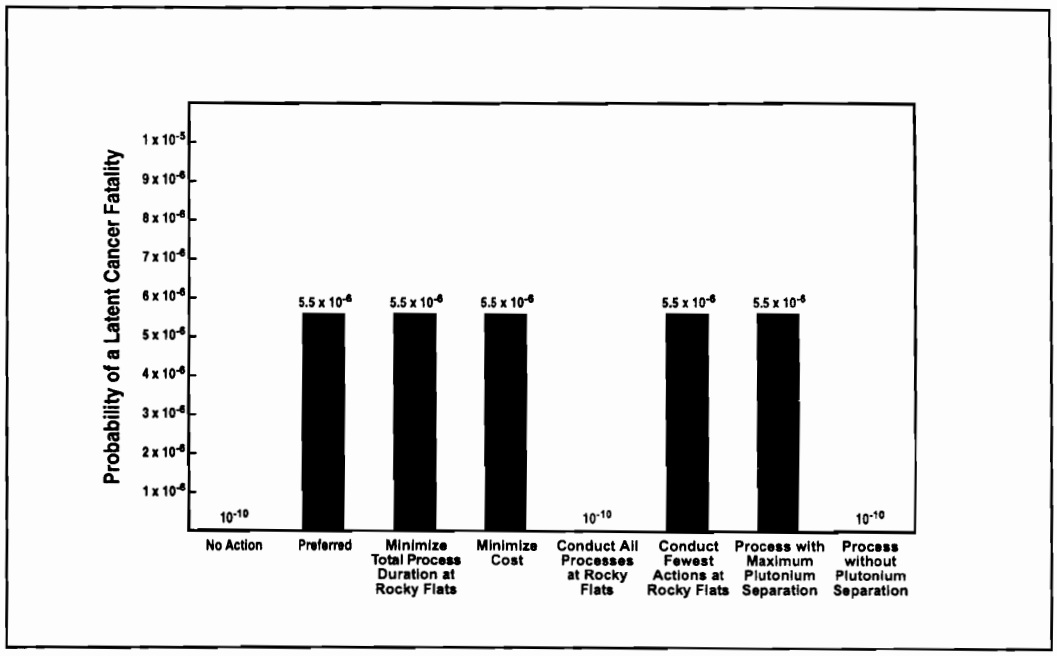


Figure 4–6 Incident-Free Radiological Risk to the Public Maximally Exposed Individual Under Each Strategic Management Approach

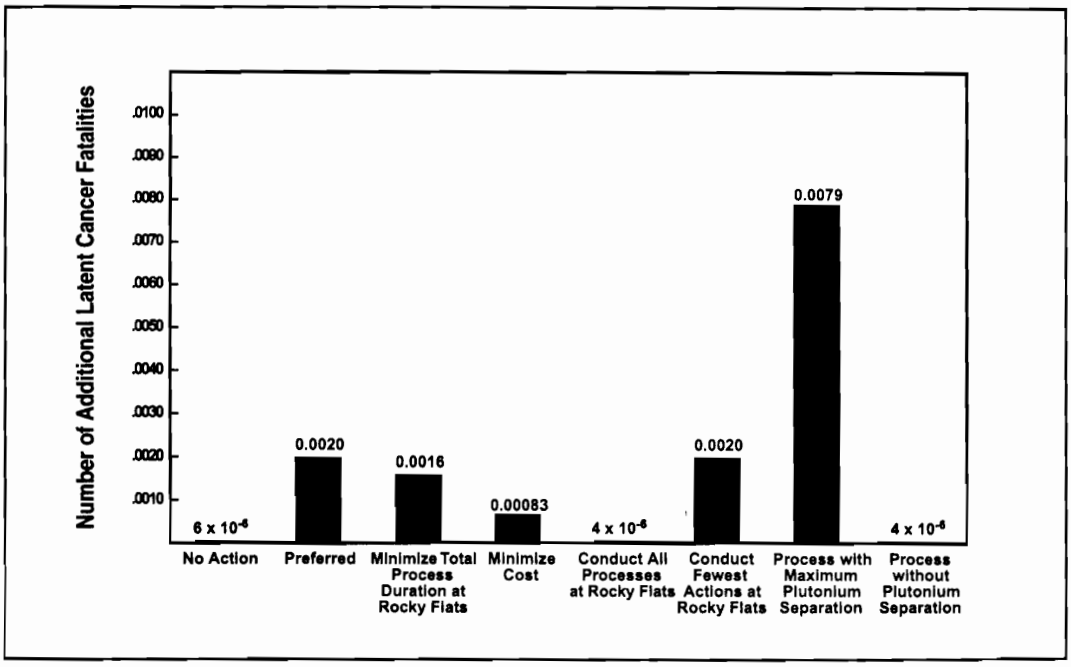


Figure 4–7 Incident-Free Radiological Risk to the Public Population Under Each Strategic Management Approach

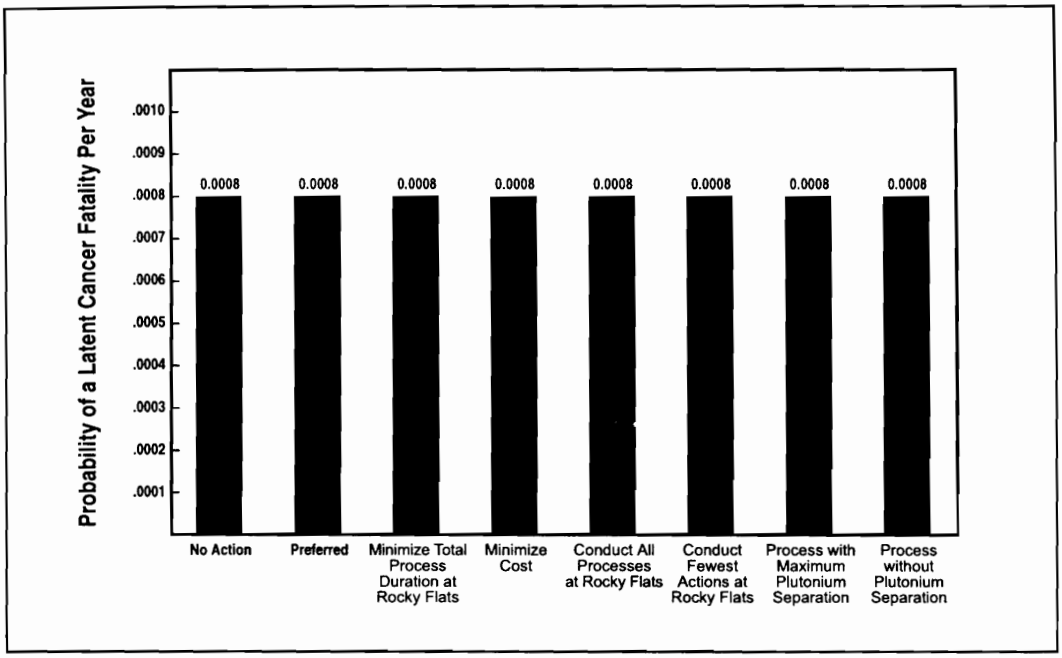


Figure 4–8 Incident-Free Radiological Risk to the Maximally Exposed Individual Worker Under Each Strategic Management Approach

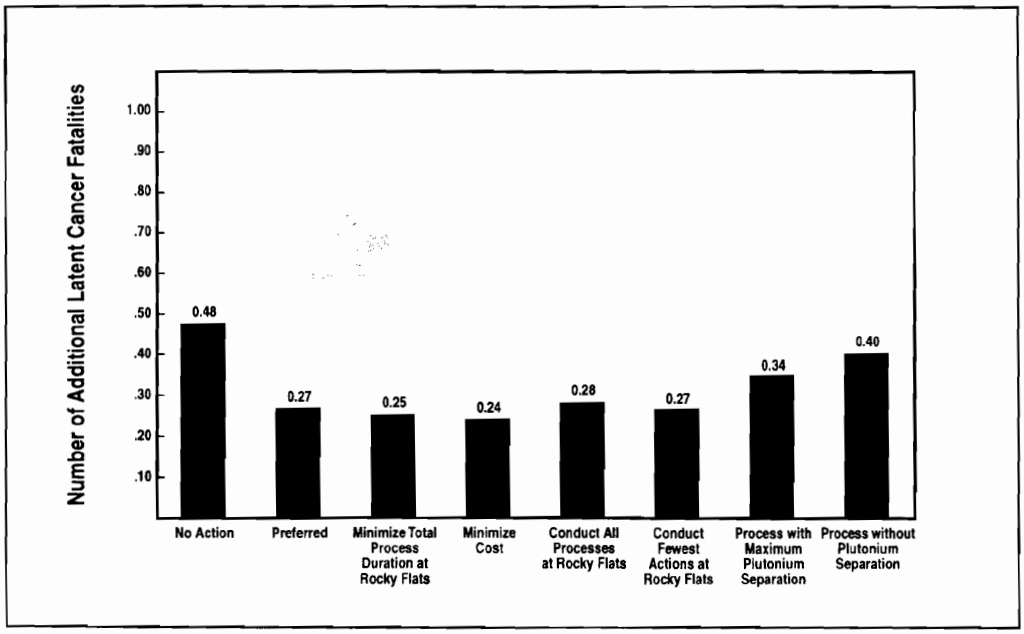


Figure 4–9 Incident-Free Radiological Risk to the Worker Population Under Each Strategic Management Approach

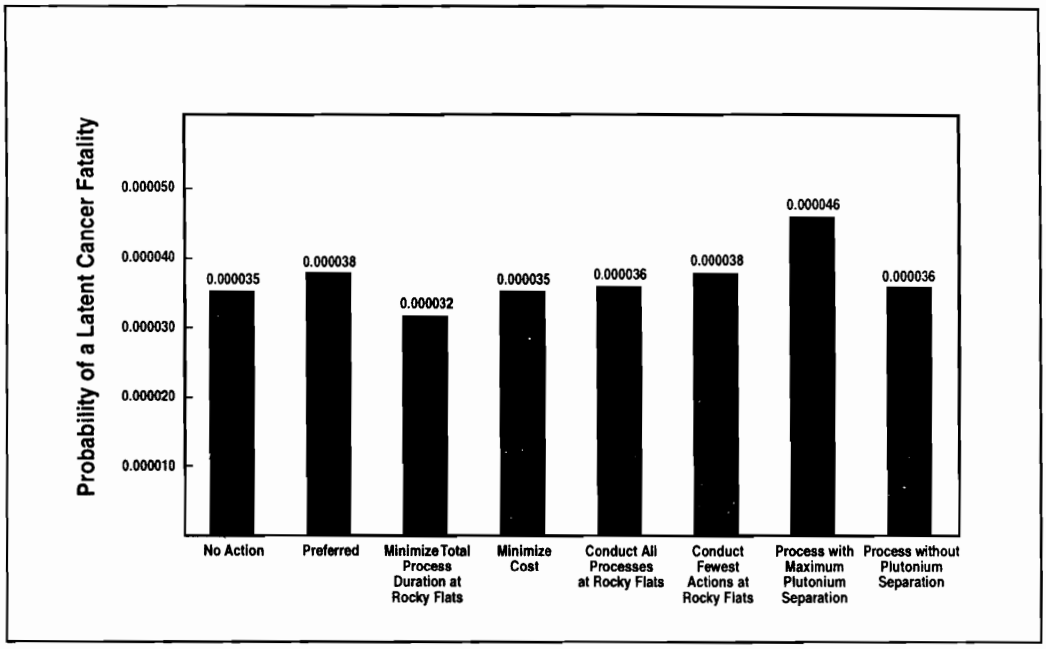


Figure 4–10 Accident Risk to the Public Maximally Exposed Individual Under Each Strategic Management Approach

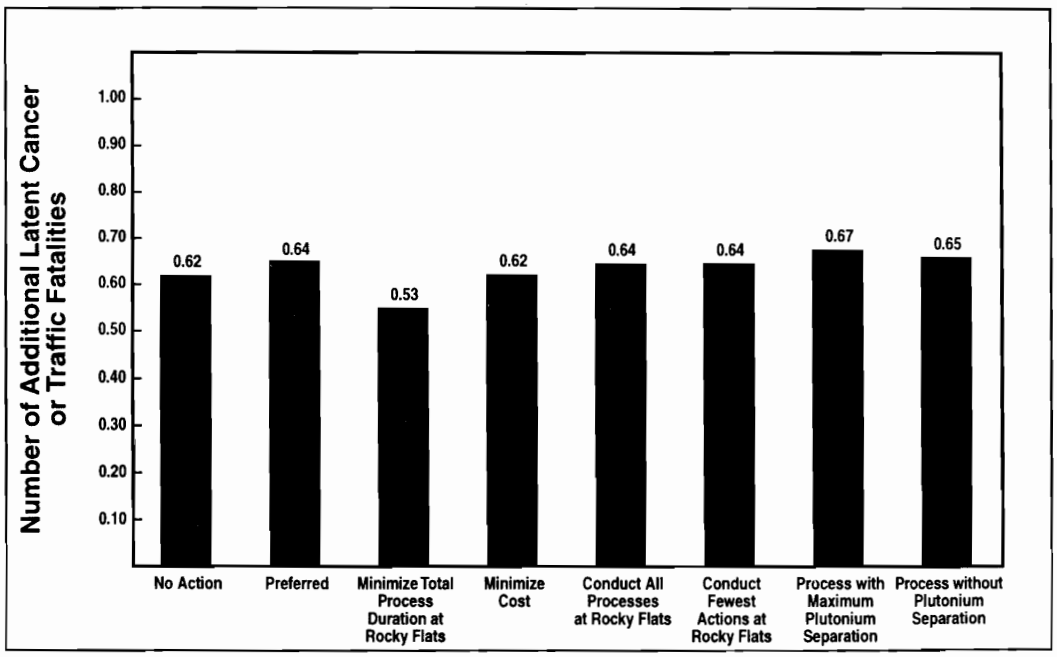


Figure 4–11 Accident Risk to the Public Population Under Each Strategic Management Approach

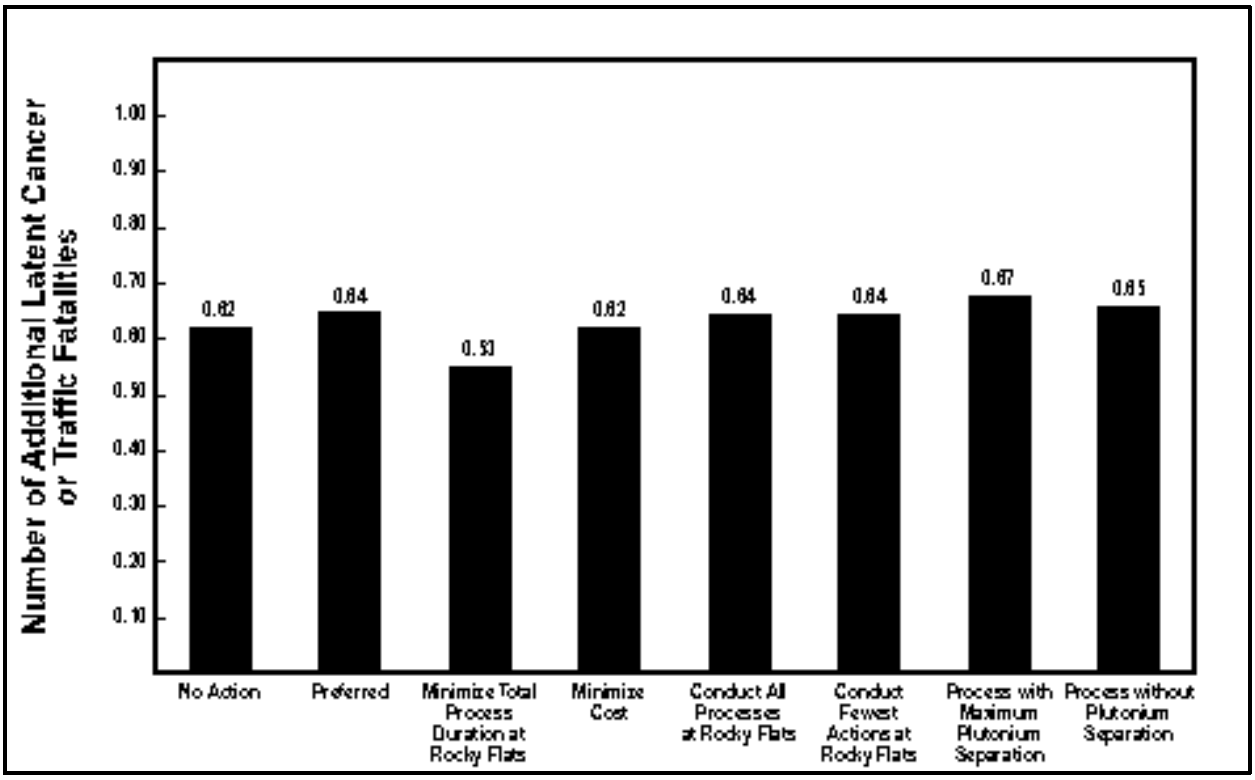


Figure 4–11 Accident Risk to the Public Population Under Each Strategic Management Approach

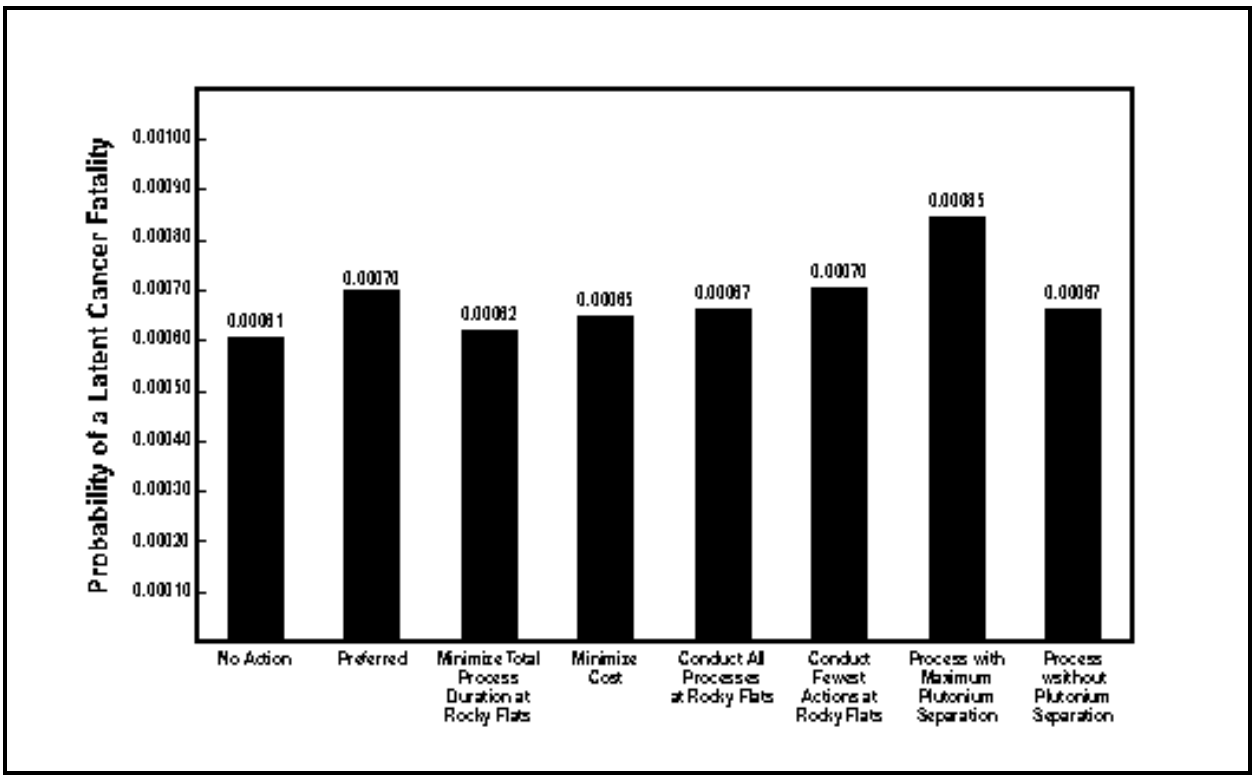


Figure 4–12 Accident Risk to the Noninvolved Onsite Worker Under Each Strategic Management Approach

residue and scrub alloy, but this one is an annual risk comparison. As shown in Figure 4–9, all the Strategic Management Approaches would cause less than 0.5 additional latent cancer fatalities among the worker population. DOE would not expect any additional worker latent cancer fatalities under any of these alternatives or management approaches. During post-processing storage, inspections of the storage facilities would expose the involved worker population to very small incremental additional doses, as discussed in Section 4.14.

As shown in Figures 4–10, 4–11, and 4–12, the risks due to onsite and transportation accidents do not vary greatly among any of the Strategic Management Approaches. In general, the Minimize Total Process Duration at Rocky Flats Management Approach presents somewhat lower accident risks than the rest of the Strategic Management Approaches, but all the accident risks are low.

4.22.3 Other Impacts

Five of the eight Strategic Management Approaches involve intersite transportation of plutonium residues and/or scrub alloy. **Figure 4-13** compares the intersite transportation that would be required under each alternative in terms of round-trip highway distances. The Process with Maximum Plutonium Separation Management Approach would require about 823,000 km (511,000 mi) of intersite transportation, while the Preferred Alternative would require about 208,000 km (129,000 mi).

The cost comparison is presented in **Figure 4-14**. Cost estimates range from $428 million for the Minimum Cost Alternative to over $1.1 billion for the No Action Alternative. The Preferred Alternative has an estimated cost of $524 million.

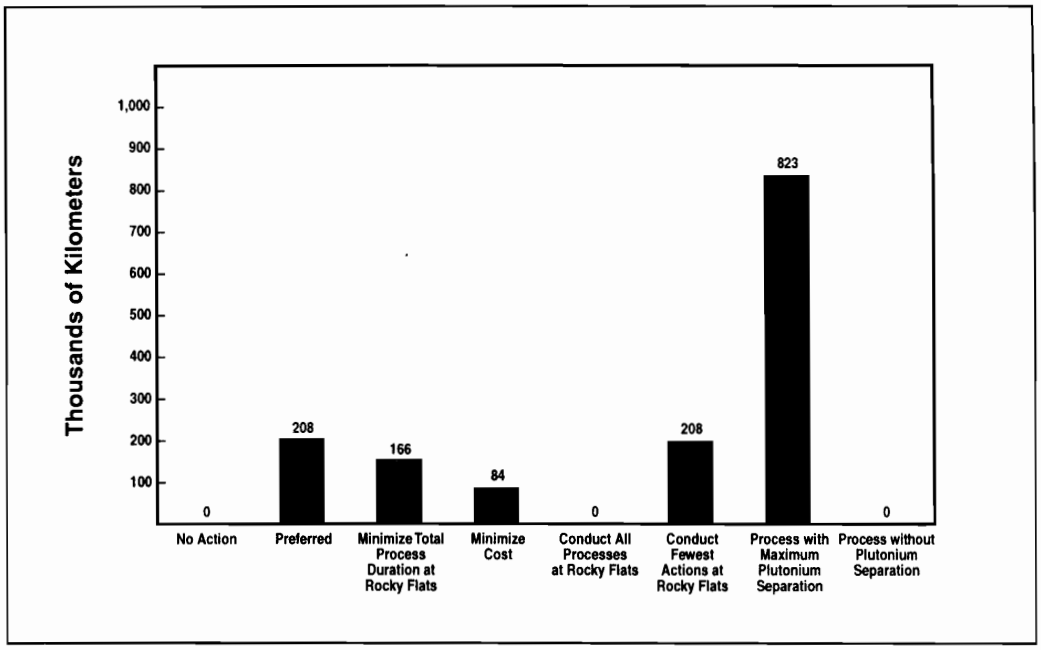


Figure 4–13 Intersite Round-Trip Transportation Required Under Each Strategic Management Approach

4.23 RANGE OF IMPACTS AT EACH SITE

As discussed in Chapter 2, DOE has identified a variety of technologies for each category or subcategory of plutonium residue and scrub alloy under Alternative 1 (No Action) and Alternative 2 (the Proposed Action). The impacts of all the technologies are presented for each residue category and subcategory in Sections 4.2 through 4.11, with each section being devoted to one residue category.

All the residues can be processed at Rocky Flats and portions of the residues can be processed at the Savannah River Site or Los Alamos National Laboratory. Sections 4.23.1 through 4.23.3 present the range of impacts that could result from the processing technology associated with the management of certain plutonium residues and scrub alloy at Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory, respectively. The low end of the range for all impacts at the Savannah River Site and at Los Alamos National Laboratory is zero; this would result if all processing were to take place at Rocky Flats or at Rocky Flats and only one other site.

4.23.1 Rocky Flats Environmental Technology Site

4.23.1.1 Products and Wastes

The processing technologies at Rocky Flats would generate stabilized residues, transuranic waste, low-level waste, and separated plutonium (with americium included) in the form of an oxide. Considering all possible processing technologies, the minimum and maximum estimated amounts of the solid plutonium-bearing products and wastes that could be generated from plutonium residues and scrub alloy at Rocky Flats are presented in **Table 4–80**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The low-level waste would be disposed of in one of the offsite disposal facilities routinely used

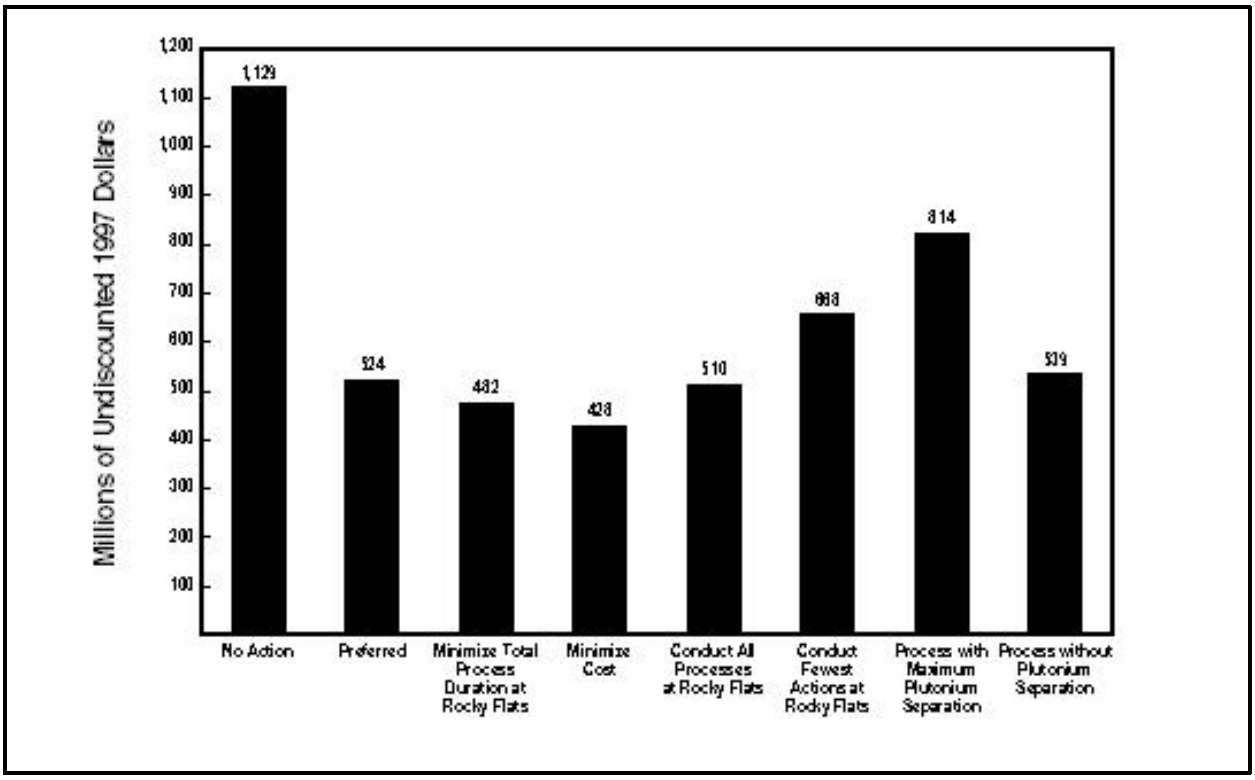


Figure 4–14 Cost of Each Strategic Management Approach

by Rocky Flats.

Table 4–80 Range of Products and Wastes at Rocky Flats

Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*Separated Plutonium (kg)* [b]	*Low-Level Waste (Drums)* [a]
0 to 21,300	2,000 to 39,200	0 to 1,399	4,100 to 57,900

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] To convert to pounds, multiply by 2.2.

As shown in Table 4–74, the storage capacity available at Rocky Flats for stabilized residues and transuranic waste combined is 13,400 drums. Table 4–80 shows that this storage capacity could be insufficient to accommodate stabilized residues and transuranic waste. This problem would only occur if DOE selects a set of processing technologies that generate large amounts of stabilized residues and transuranic waste and shipments to WIPP are delayed. In this case, a new storage facility would have to be constructed at Rocky Flats.

If, on the other hand, DOE selects the Preferred Alternative and WIPP opens on time, then the existing transuranic waste storage capacity will be adequate.

4.23.1.2 Public and Occupational Health and Safety Impacts

This section describes the range of radiological and hazardous chemical impacts which could result from the various processing technologies associated with the management of Rocky Flats plutonium residues and scrub alloy at Rocky Flats. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. Detailed analyses associated with these impacts are presented in Appendix D.

No construction of new facilities is required for any of the alternatives, but DOE may need to modify certain existing facilities. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.23.1.2.1 Incident-Free Operations

Radiological Impacts—The range of radiological impacts to the public and the workers associated with incident-free implementation of the various processing technologies at Rocky Flats is presented in **Table 4–81**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of plutonium residues and scrub alloy. The length of time necessary to process all the plutonium residues and scrub alloy will depend on which technologies DOE decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce worker impacts, but these are very small compared to the impacts due to processing (see Section 4.14).

Table 4–81 Range of Radiological Impacts Due to Incident-Free Operations at Rocky Flats

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0.00012 to 0.00105	6.0×10^{-11} to 5.3×10^{-10}	0.0046 to 0.024	2.3×10^{-6} to 0.000012

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Maximally Exposed Individual Involved Worker		*Involved Worker Population*	
Dose (mrem per year)	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
2,000	0.00080	425 to 2,040	0.17 to 0.82

The public maximally exposed individual at Rocky Flats would be a hypothetical individual who lives downwind at the site boundary. As shown in Table 4–81, the estimated total dose for this maximally exposed individual could range from about 0.0001 mrem to 0.001 mrem. This individual's chance of incurring a latent cancer fatality due to process operations would be less than one in one billion.

The total public population radiation dose, as shown in Table 4–81, could range from 0.0046 person-rem to 0.024 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would range from 425 person-rem to 2,040 person-rem, which would cause 0.17 to 0.82 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to very small incremental additions.

Hazardous Chemical Impacts—The range of impacts of hazardous chemical releases associated with incident-free implementation of the various processing technologies at Rocky Flats is presented in **Table 4–82**. The probability of excess latent cancer incidence for the offsite population maximally exposed individual resulting from releases of carbon tetrachloride ranges from 0 to 6×10^{-11}. This hypothetical individual's chance of incurring a latent cancer would be increased by less than one in ten billion. From zero to less than one latent cancer incidence is expected to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The Hazard Index range of 0 to 5×10^{-11} resulting from releases of hydrochloric acid suggests that noncancer adverse health effects are not expected in the offsite population.

Table 4–82 Range of Chemical Impacts at Rocky Flats

Offsite Public Maximally Exposed Individual		*Offsite Public Population*
Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences or Fatalities***
0 to 6×10^{-11}	0 to 5×10^{-11}	0 to <1
Maximally Exposed Individual Worker		*Noninvolved Worker Population*
Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences or Fatalities***
0 to 3×10^{-9}	0 to 3×10^{-9}	0 to <1

The maximally exposed individual involved worker probability of excess latent cancer incidence ranges from 0 to 3×10^{-9}. This hypothetical individual's chance of incurring a latent cancer would be increased by less than one in one hundred million. If all site workers were exposed to the maximally exposed individual

concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than 1 excess latent cancer would be expected to occur in the workforce population. The Hazard Index range of 0 to 3×10^{-9} suggests that noncancer adverse health effects are not expected in the involved worker population as a result of exposure to hydrochloric acid.

4.23.1.2.2 Accidents

The range of radiological impacts to the public and the noninvolved onsite workers due to accidents during the implementation of the various processing technologies for plutonium residues and scrub alloy at Rocky Flats is presented in **Table 4–83**. The length of time necessary to process all the residues and scrub alloy will depend on which technologies DOE decides to implement.

Table 4–83 Range of Radiological Impacts[a] Due to Accidents at Rocky Flats

Offsite Public Maximally Exposed Individual Risk	*Offsite Public Population Risk*	*Noninvolved Onsite Worker Maximally Exposed Individual Risk*
Probability of a Latent Cancer Fatality	*Number of Latent Cancer Fatalities*	*Probability of a Latent Cancer Fatality*
0.0000027 to 0.000042	0.031 to 0.66	0.000027 to 0.00067

[a] The impacts are given as risks, which are additive, rather than consequences, which are not additive for accidents.

The public maximally exposed individual at Rocky Flats would be a hypothetical individual who lives downwind at the site boundary. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The estimated risk of a latent cancer fatality for the maximally exposed individual could range from 0.0000027 to 0.000042. This individual's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in ten thousand. The estimated risk of latent cancer fatalities for the general population could be in the range of 0.031 to 0.66. This accident risk could cause one additional latent cancer fatality in the population living near Rocky Flats. The noninvolved onsite worker risk is in the range of 0.000027 to 0.00067. This noninvolved onsite worker's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in one thousand.

In any accident scenario, the individuals most likely to be injured are the involved workers. The risk to these workers would be due to both radiological and nonradiological effects. In a fire, the involved workers could be exposed to airborne radioactive material, in addition to the smoke an heat of the fire. In an explosion, there could be flying debris and containment barriers could be broken, exposing workers to airborne radioactive material. Most spills would not have a major effect on involved workers because they would clean up the spill wearing protective clothing and respirators as necessary. An accidental criticality could expose involved workers to large doses of prompt penetrating radiation, which could cause death in a short period of time. The earthquake and aircraft crash accident scenarios present very severe nonradiological effects to the involved workers. In these scenarios, the workers are likely to be hurt or killed from the collapse of the building or the impact of the aircraft crash before they could be evacuated.

The maximum number of involved workers at risk is estimated to be equal to the number of workers who would be working on plutonium residues or scrub alloy at any one time in each of the processing buildings at each of the three sites. Building 707 and 371 at Rocky Flats would each have about 100 involved workers inside,

which is more involved workers than any facility at either of the other two sites. Thus, if an earthquake strong enough to collapse Building 707 and damage Building 371 hits Rocky Flats, approximately 200 involved workers would be at risk of death or injury due to activities associated with plutonium residues and scrub alloy. The estimated frequencies of earthquakes that could collapse Buildings 707 and 371 are 0.0026 and 0.000094 per year, respectively.

4.23.2 Savannah River Site

4.23.2.1 Products and Wastes

The processing technologies at the Savannah River Site would generate high-level waste, transuranic waste, saltstone, low-level waste, and separated plutonium in the form of a metal and/or an oxide. The americium from the residues would go into the high-level waste. Considering all possible processing technologies, the minimum and maximum estimated amounts of the solid plutonium-bearing products and wastes that could be generated from plutonium residues and scrub alloy at the Savannah River Site are presented in **Table 4–84**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The high-level waste canisters would be stored onsite until a monitored geologic repository is ready to receive them. The separated plutonium would be stored onsite until a decision is made on its disposition. The low-level waste and saltstone would be disposed of in the onsite disposal facilities at the Savannah River Site.

Table 4–84 Range of Products and Wastes at the Savannah River Site

Transuranic Waste (Drums)[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)*[c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
0 to 500	0 to 43	0 to 2,521	0 to 1,100	0 to 2,500

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.

4.23.2.2 Public and Occupational Health and Safety Impacts

This section describes the range of radiological and hazardous chemical impacts which could result from the various processing technologies associated with the management of certain Rocky Flats residues and scrub alloy at the Savannah River Site. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. Detailed analyses associated with these impacts are presented in Appendix D.

No construction of new facilities is required for any of the alternatives, but DOE may need to modify certain existing facilities. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.23.2.2.1 Incident-Free Operations

Radiological Impacts—The range of radiological impacts to the public and the workers associated with incident-free implementation of the various processing technologies at the Savannah River Site is presented in **Table 4–85**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the applicable inventory of residues and scrub alloy. The length of time necessary to process the residues and scrub alloy will depend on which technologies DOE

decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce impacts, but these are very small compared to the impacts due to processing.

Table 4–85 Range of Radiological Impacts Due to Incident-Free Operations at the Savannah River Site

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
0 to 0.0034	0 to 1.7×10^{-9}	0 to 0.38	0 to 0.00019
Maximally Exposed Individual Involved Worker		***Involved Worker Population***	
Dose (mrem per year)	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
0 to 2,000	0 to 0.00080	0 to 469	0 to 0.19

The public maximally exposed individual at the Savannah River Site would be a hypothetical individual who lives downwind at the site boundary. As shown in Table 4–85, the estimated total dose for this maximally exposed individual could range from 0 mrem to 0.0034 mrem. This individual's chance of incurring a latent cancer fatality due to process operations would be less than one in one-hundred million.

The total public population radiation dose, as shown in Table 4–85, could range from 0 person-rem to 0.38 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would range from 0 to approximately 469 person-rem, which would cause 0 to 0.19 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to small incremental additions. When the Actinide Packaging and Storage Facility becomes operational, these inspections will be done remotely, so the worker dose will go down to zero.

Hazardous Chemical Impacts—The range of impacts of hazardous chemical releases associated with incident-free implementation of the various processing technologies at the Savannah River Site is presented in **Table 4–86**. No carcinogenic chemicals are expected to be released from the processing of plutonium residues and scrub alloy at the Savannah River Site; therefore, maximally exposed individual cancer probability and population cancer incidences were not evaluated for the offsite population or workers. The Hazard Index range of 0 to 2×10^{-9} suggests that noncancer adverse health effects are not expected in the offsite population as a result of releases of phosphoric acid and ammonium nitrate. The Hazard Index range of 0 to 2×10^{-8} indicates that onsite workers are not expected to experience adverse noncancer health effects.

Table 4–86 Range of Chemical Impacts at the Savannah River Site

Offsite Public Maximally Exposed Individual		*Offsite Public Population*
Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences***
N/A	0 to 2×10^{-9}	N/A

Maximally Exposed Individual Worker		Noninvolved Worker Population
Probability of Cancer Incidence	Hazard Index	Number of Cancer Incidences
N/A	0 to 2×10^{-8}	N/A

N/A = not applicable

4.23.2.2.2 Accidents

The range of radiological impacts to the public and the noninvolved onsite workers due to accidents during the implementation of the various processing technologies for plutonium residues and scrub alloy at the Savannah River Site is presented in **Table 4–87**. The length of time necessary to process all the residues and scrub alloy will depend on which technologies DOE decides to implement.

Table 4–87 Range of Radiological Impacts Due to Accidents at the Savannah River Site

Offsite Public Maximally Exposed Individual Risk	Offsite Public Population Risk	Noninvolved Onsite Worker Maximally Exposed Individual Risk
Probability of a Latent Cancer Fatality	Number of Latent Cancer Fatalities	Probability of a Latent Cancer Fatality
0 to 2.5×10^{-7}	0 to 0.011	0 to 0.000078

[a] The impacts are given as risks, which are additive, rather than consequences, which are not additive for accidents.

The public maximally exposed individual at the Savannah River Site would be a hypothetical individual who lives downwind at the site boundary. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The estimated risk of a latent cancer fatality for the maximally exposed individual could range from 0 to 2.5×10^{-7}. This individual's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in one million. The estimated risk of latent cancer fatalities for the general population could be in the range of 0 to 0.011. The noninvolved onsite worker risk is in the range of 0 to 0.000078. This onsite worker's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in ten thousand.

4.23.3 Los Alamos National Laboratory

4.23.3.1 Products and Wastes

The processing technologies at Los Alamos National Laboratory would generate high-level waste, transuranic waste, and low-level waste, and would also produce separated plutonium in the form of an oxide. Considering all possible processing technologies, the minimum and maximum estimated amounts of the solid plutonium-bearing products and wastes that could be generated from plutonium residues and scrub alloy at the Los Alamos National Laboratory are presented in **Table 4–88**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The low-level waste would be disposed of at the onsite disposal facilities at Los Alamos National Laboratory.

Table 4–88 Range of Products and Wastes at Los Alamos National Laboratory

Transuranic Waste (Drums)[a]	*Separated Plutonium (kg)*[b]	*Low-Level Waste (Drums)*[a]
0 to 3,000	0 to 980	0 to 6,200

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] To convert to pounds, multiply by 2.2.

4.23.3.2 Public and Occupational Health and Safety Impacts

This section describes the range of radiological and hazardous chemical impacts which could result from the processing technologies associated with the management of certain Rocky Flats residues at the Los Alamos National Laboratory. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. Detailed analyses associated with these impacts are presented in Appendix D.

No construction of new facilities is required for any of the alternatives, but DOE may need to modify certain existing facilities. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.23.3.2.1 Incident-Free Operations

Radiological Impacts—The range of radiological impacts to the public and the workers associated with incident-free implementation of applicable processing technologies at Los Alamos National Laboratory is presented in **Table 4–89**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the inventory of applicable residues. The length of time necessary to process the residues will depend on which technology(s) DOE decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce impacts, but these are very small compared to the impacts due to processing.

Table 4–89 Range of Radiological Impacts Due to Incident-Free Operations at Los Alamos National Laboratory

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0 to 0.00080	0 to 4.0×10^{-10}	0 to 0.0024	0 to 1.2×10^{-6}
Maximally Exposed Individual Involved Worker		*Involved Worker Population*	
Dose (mrem per year)	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0 to 2,000	0 to 0.00080	0 to 160	0 to 0.064

The public maximally exposed individual at Los Alamos National Laboratory would be a hypothetical individual who lives downwind at the site boundary. As shown in Table 4–89, the estimated total dose for this maximally exposed individual could range from 0 mrem to 0.00080 mrem. This individual's chance of incurring a latent cancer fatality due to process operations would be less than one in one-billion.

The total public population radiation dose, as shown in Table 4–89, could range from 0 person-rem to 0.0024 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would range from 0 person-rem to approximately 160 person-rem, which would cause 0 to 0.064 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to small incremental additions.

Hazardous Chemical Impacts—No hazardous chemicals are expected to be released from the proposed processing of plutonium residues at Los Alamos National Laboratory under the various processing technologies evaluated in this EIS.

4.23.3.2.2 Accidents

The range of radiological impacts to the public and the noninvolved onsite workers due to accidents during the implementation of the various processing technologies for plutonium residues at Los Alamos National Laboratory is presented in **Table 4–90**. The length of time necessary to process all the residues will depend on which technologies DOE decides to implement.

Table 4–90 Range of Radiological Impacts Due to Accidents at Los Alamos National Laboratory

Offsite Public Maximally Exposed Individual Risk	*Offsite Public Population Risk*	*Noninvolved Onsite Worker Maximally Exposed Individual Risk*
Probability of a Latent Cancer Fatality	***Number of Latent Cancer Fatalities***	***Probability of a Latent Cancer Fatality***
0 to 0.000028	0 to 0.037	0 to 0.00048

[a] The impacts are given as risks, which are additive, rather than consequences, which are not additive for accidents.

The public maximally exposed individual at the Los Alamos National Laboratory would be a hypothetical individual who lives downwind at the site boundary. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The estimated risk of a latent cancer fatality for the maximally exposed individual could range from 0 to 0.000028. This individual's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in ten thousand. The estimated risk of latent cancer fatalities for the general population could be in the range of 0 to 0.037. The noninvolved onsite worker risk is in the range of 0 to 0.00048. This noninvolved onsite worker's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in one thousand.

4.24 RANGE OF INTERSITE TRANSPORTATION IMPACTS

As discussed in Chapter 2, DOE has identified a variety of options under Alternative 3, Process with Plutonium Separation, that would require transporting plutonium residues or scrub alloy from Rocky Flats to either the Savannah River Site or Los Alamos National Laboratory. Considering all the options, the number of truck shipments from Rocky Flats to the Savannah River Site could range from zero to 208. Similarly, the number of truck shipments from Rocky Flats to Los Alamos National Laboratory could range from zero to 63. The detailed analysis of the intersite transportation impacts are presented in Appendix E, Sections E.5 and E.6.

The range of radiological impacts due to incident-free transportation along each potential transportation route is presented in **Table 4–91**. These results are all based on the conservative assumption that the dose rate is 10 mrem per hour at 2 m (6.6 ft) from the side of the truck. See Section 4.2.2.1 for additional information on the conservative nature of the transportation analyses. For every impact, the low end of the range is always zero because some options involve no transportation. The high end of each range is always very low, which indicates that DOE would expect no latent cancer fatalities from any combination of transportation options.

Table 4–91 Range of Offsite Radiological Impacts Due to Incident-Free Offsite Transportation

	Public Maximally Exposed Individual		*Public Population*	
Origin/Destination	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Rocky Flats/Savannah River Site	0 to 11	0 to 5.5×10^{-6}	0 to 21	0 to 0.010
Rocky Flats/Los Alamos National Laboratory	0 to 11	0 to 5.5×10^{-6}	0 to 1.7	0 to 0.00085
	Maximally Exposed Individual Transport Worker		*Transport Worker Population*	
Origin/Destination	*Dose (mrem per year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Rocky Flats/Savannah River Site	0 to 100	0 to 0.000040	0 to 32	0 to 0.013
Rocky Flats/Los Alamos National Laboratory	0 to 100	0 to 0.000040	0 to 2.6	0 to 0.0010

The only chemical impact would be latent cancer fatalities due to vehicle exhaust. The vehicle exhaust gases from the maximum number of truck shipments (round-trip) from Rocky Flats to the Savannah River Site and Los Alamos National Laboratory could cause up to 0.0027 and 0.00029 latent cancer fatalities, respectively.

The potential impacts due to transportation accidents are presented in **Table 4–92**. For every impact, the low end of the range is always zero because some options involve no transportation. The table shows that the risk of prompt death due to the trauma of a traffic accident is much greater than the risk due to radiological exposure following an accident. The highest risk is 0.021, which means that there would be about a 2-percent chance of one traffic fatality if DOE decides to make all 208 possible truck shipments to the Savannah River Site.

Table 4–92 Range of Risks Due to Transportation Accidents

	Offsite Public Population Radiological Risk	*Offsite Public and Worker Trauma Risk*
Origin/Destination	*Number of Latent Cancer Fatalities*	*Probability of One Traffic Fatality*
Rocky Flats/Savannah River Site	0 to 6.0×10^{-6}	0 to 0.021
Rocky Flats/Los Alamos National Laboratory	0 to 3.6×10^{-7}	0 to 0.0018

4.25 KEY CUMULATIVE IMPACTS AT THE POTENTIAL PROCESSING SITES AND DURING INTERSITE TRANSPORTATION

All of the potential processing sites for the Rocky Flats plutonium residues and scrub alloy have facilities unrelated to the management of these materials. These other facilities may continue to operate throughout the same period during which the residues and scrub alloy are processed (approximately 5 to 10 years). Impacts

from operation of the plutonium residue and scrub alloy processing facilities would be cumulative with the impacts of existing and planned facilities or actions such as environmental restoration and waste management activities which are unrelated to processing and management of the residues and scrub alloy.

This section presents the cumulative impacts at each of the three sites that may process residues and scrub alloy. It also presents the cumulative impacts of transporting these materials for potential processing at the Savannah River Site and at Los Alamos National Laboratory. To obtain the cumulative site impacts, the range of impacts from processing the residues and scrub alloy at each site are added to the impacts from existing and planned actions unrelated to residue or scrub alloy processing. The impacts from existing and planned actions are taken from the information presented in the Waste Management Programmatic Environmental Impact Statement (DOE 1997c). Cumulative impacts from transportation are derived from information given in Section 4.24 and Appendix E.

In compliance with the Clean Air Act (42 U.S.C. 7401), EPA has promulgated National Ambient Air Quality Standards for six criteria air pollutants (40 CFR Part 50): carbon monoxide (CO), sulfur dioxide (SO_2), particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb). These pollutants are regulated both in terms of annual production in tons per year and in terms of ambient concentrations emanating from point and mobile sources. Unlike the other five criteria air pollutants, ozone is not a direct emission but is formed in the atmosphere through a complex reaction of ozone precursor pollutants, sunlight, and temperature. Ozone precursor pollutants include nitrogen oxides (NO_X) and nonmethane hydrocarbons, which include the class of compounds known as volatile organic compounds.

Criteria air pollutants can be emitted from equipment used to modify facilities, vehicles from workers traveling to and from the site, from operation and maintenance of processing facilities, and from safe, secure trailers used to transport plutonium residues and scrub alloy from Rocky Flats to the Savannah River Site and Los Alamos National Laboratory. In this EIS, DOE considers that the implementation of mitigation measures would effectively prevent emissions of criteria air pollutants during facility modifications. Although new equipment may be added to existing facilities, no new facilities would be constructed for any of the technologies. DOE has also considered that no increase in criteria air pollutants emitted by vehicles driven by workers traveling to and from each site because the number of workers at each site would not change dramatically due to the implementation of any processes described in the EIS (see Section 4.18).

4.25.1 Cumulative Impacts at the Rocky Flats Environmental Technology Site

Aside from the continuation of existing operation and waste management activities at Rocky Flats, reasonably foreseeable future actions at Rocky Flats include the transfer of certain Nuclear Weapons Complex nonnuclear functions from Rocky Flats to other sites (DOE 1993a) and environmental restoration activities. **Tables 4–93** and **4–94** identify the ranges of cumulative impacts resulting from the management of the plutonium residues and scrub alloy addressed in this EIS, other future actions, and current activities. Future and ongoing cleanup actions include remediation of contaminated groundwater, solidification and disposition of solar pond sludge, and decontamination and decommissioning of facilities.

Table 4–93 Rocky Flats Cumulative Radiological Impacts

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
Waste Generation									
Stabilized Residues (drums)[e]		0	0	21,300	18,400	0	0	21,300	17,600

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
Transuranic Waste (cubic meters)	1	6,300	400	8,200	500	4,900	11,600	19,400	11,700
Low-Level Waste (cubic meters)	1	41,000	900	12,100	900	96,000	138,000	149,000	138,000
Low-Level Mixed Waste (cubic meters)	1	21,000	0	0	0	192,000	213,000	213,000	213,000
Offsite Population									
Collective dose, 10 years (person-rem)	2	1.6	0.0046	0.024	0.0057	228	230	230	230
Number of latent cancer fatalities from collective dose	3	0.00080	2.3×10^{-6}	0.000012	2.9×10^{-6}	0.11	0.11	0.11	0.11
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	4	0.00047	0.00012	0.00105	0.00019	0.23	0.23	0.23	0.23
Probability of a latent cancer fatality	5	2.3×10^{-10}	6.0×10^{-11}	5.3×10^{-10}	9.5×10^{-11}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}
Worker Population									
Collective dose, 10 years (person-rem)	6	2,630	425	2,040	582	1,723	4,778	6,393	4,935
Number of latent cancer fatalities from collective dose	7	1.1	0.17	0.82	0.23	0.69	2.0	2.6	2.0

[a] Other reasonably foreseeable future actions include special nuclear materials management; deactivation, decontamination, and decommissioning of Rocky Flats facilities; and environmental restoration activities (DOE 1997).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 1.6-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.) Most of these stabilized residues could be disposed of in WIPP as transuranic waste.

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) fromTables B.5-1, B.5-2, and B.5-3 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.

(2) Assumes all facilities operate concurrently for the same 10-year period. The dose due to existing operations is from Table 11.15-2 of DOE 1997c. The dose due to other reasonably foreseeable future actions is from Table 5.8-5 of DOE 1997, minus the dose due to existing operations.

(3) Assumes 0.0005 latent cancer fatalities per person-rem.

(4) Based on (DOE 1994e) for existing operations, which contains releases for the year 1992. The dose due to other reasonably foreseeable future actions is from Table 5.8-4 of DOE 1997.

(5) Assumes 5×10^{-7} latent cancer fatalities per mrem.

(6) Assumes that all facilities operate concurrently for the same 10-year period. The dose due to existing operations is based on the 1996 dose to workers of 263 person-rem (DOE 1997). The dose due to other reasonably foreseeable future actions is the sum of the doses in Table 5.8-1 of DOE 1997, minus the dose for residue management.

(7) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 4–94 Cumulative Air Quality Impacts at Rocky Flats

Pollutant	Baseline Concentration ($\mu g/m^3$)	Modeled Concentration ($\mu g/m^3$)	Concentration from Other Onsite Sources[a] ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	Averaging Time	Most Stringent Regulation or Guideline ($\mu g/m^3$)
Nitrogen Dioxide	1.4	0.00014	0.0	1.4	Annual	100
Hydrochloric Acid	0.0052	4.2×10^{-7}	0.001	0.0062	Annual	N/A
Carbon Tetrachloride	0.0024	0.000031	0.002	0.0044	Annual	N/A

N/A = not applicable

[a] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Rocky Flats, based on *Rocky Flats Cumulative Impacts Document*, (DOE 1997).

Wastes—As shown in Table 4-93, existing operations and other reasonably foreseeable future actions would not generate any stabilized residues, which have plutonium concentrations above the safeguards termination limits. The minimum amount of stabilized residues that could be generated under this EIS is also zero because for every material category there is at least one processing technology that would not generate any. Alternatives 1 and 4 would generate stabilized residues, while Alternatives 2 and 3 would not.

As shown in Table 4–93, existing operations and reasonably foreseeable future actions at Rocky Flats will generate approximately 11,200 m^3 (395,500 ft^3) of transuranic waste. The minimum and maximum amounts of transuranic waste to be generated from plutonium residues and scrub alloy are given in Table 4–80 in terms of numbers of drums. To compare the two, the numbers of drums from Table 4–80 were converted to cubic meters (4.8 drums per cubic meter), and then listed in Table 4–93. The maximum estimated volume of transuranic waste from plutonium residues and scrub alloy is 8,200 m^3 (293,000 ft^3), which would represent a major increase over the 11,200 m^3 (395,500 ft^3) from existing operations

As shown in Table 4–93, existing operations and reasonably forseeable future actions at Rocky Flats will generate approximately 137,000 m^3 (4,840,000 ft^3) of low-level waste. The minimum and maximum amounts of low-level waste to be generated from managing plutonium residues and scrub alloy are given in Table 4–80 in terms of numbers of drums. These values were converted to cubic meters and then listed in Table 4–93. The maximum estimated volume from plutonium residues and scrub alloy is 12,100 m^3 (430,000 ft^3), which would represent an increase of less than 10 percent of the 137,000 m^3 (4,840,000 ft^3) from existing operations and reasonably forseeable future actions.

Table 4–93 also shows that the largest volume of waste at Rocky Flats is low-level mixed waste. DOE has estimated that existing operations and reasonably forseeable actions will generate more than 200,000 m^3 (7,000,000 ft^3) of low-level mixed waste, while the processing of plutonium residues and scrub alloy is not expected to generate any low-level mixed waste.

Radiological Impacts—As identified in Table 4–93, the radioactive releases that would result from processing the Rocky Flats plutonium residues and scrub alloy would not noticeably increase the radiation dose or the associated number of latent cancer fatalities in the offsite population. In addition, the radiation dose to the maximally exposed offsite individual would remain well below the DOE regulatory limit of 10 mrem per year from atmospheric releases (DOE Order 5400.5). The radiation dose to the involved worker population could increase by as much as 78 percent of the dose from existing operations over the 10-year processing periods. However, doses to individual involved workers will be kept below the regulatory limit of 5,000 mrem per year (10 CFR Part 835). Furthermore, as low as reasonably achievable principles will be exercised to maintain individual worker doses below the DOE Administrative Control Level of 2,000 mrem per year (DOE 1994d). Each DOE site also maintains its own Administrative Control Level, but for the sake of consistency, DOE used the 2,000 mrem per year level throughout this EIS. Transportation workers (e.g., drivers) will be held to an annual limit of 100 mrem per year because they are not certified radiation workers. All worker doses are routinely monitored, and if any individual worker's dose approaches the annual limit, he or she would be rotated into another job.

Air Quality Impacts—The processing of plutonium residues and scrub alloy at Rocky Flats would involve potential releases of nitrogen oxide, carbon tetrachloride, and hydrochloric acid. The modeled offsite concentrations of these pollutants from Section 4.12 are presented in Table 4–94, along with the existing site concentrations (from Table 3–5) and concentrations from other onsite sources that would be operating at the same time as the plutonium residues and scrub alloy processing.

Because the total site concentrations are small compared to the standards or guidelines, the cumulative impacts of the proposed action, the existing site baseline, and other onsite sources should not be of concern with respect to these pollutants at Rocky Flats. Ambient air concentrations based on monitoring data and modeled data from nearby non-DOE sources are discussed in Section 3.1.3. If these ambient air concentrations are combined with the concentrations in Table 4–94, the resulting concentrations would be well below the air quality standards and guidelines. Note that combining the site's concentrations with the ambient concentrations is very conservative, as it is expected that the monitors would be impacted by Rocky Flats emission sources in addition to non-DOE sources.

Rocky Flats is in a nonattainment area where standards for concentrations of criteria air pollutants are exceeded for particulates, carbon monoxide, and ozone. Section 176c of the 1990 Clean Air Act as amended requires that all Federal actions conform with the applicable State Implementation Plan. EPA has implemented rules that establish the criteria and procedures governing the determination of conformity for all Federal actions in nonattainment and maintenance areas (40 CFR 93.153). Since Rocky Flats is located in a nonattainment area for particulates, carbon monoxide, and ozone, proposed actions at this site have been evaluated and it has been determined that the total direct and indirect emissions associated with the proposed actions are below the emissions level for which a conformity determination is required (See Section 4.12).

4.25.2 Cumulative Impacts at the Savannah River Site

Aside from the continuation of existing operations and the activities addressed in this EIS, reasonably foreseeable future actions at the Savannah River Site include continued management of spent nuclear fuels (DOE 1995e), tritium supply and recycling (DOE 1995a), processing of F-Canyon plutonium solutions to plutonium metal (DOE 1994a), interim management of nuclear materials (DOE 1995b), operation of the Defense Waste Processing Facility (DOE 1994c), other site projects for the management of waste (including environmental restoration activities) (DOE 1995d), storage and disposition of weapons-usable fissile materials (DOE 1996a), stockpile stewardship and management (DOE 1996b), and disposition of surplus highly enriched uranium (DOE 1996c).

Tables 4–95 and **4–96** identify the ranges of cumulative waste and radiological impacts resulting from these other actions, the processing of Rocky Flats plutonium residues and scrub alloy, and current activities that include atmospheric radiological releases from the Vogtle Nuclear Power Plant, located near the Savannah River Site. Table 4–95 includes the impacts of the Savannah River Site managing aluminum-clad spent nuclear fuel, as recently analyzed and decided by DOE (DOE 1995e).

Table 4–95 Savannah River Site Cumulative Radiological Impacts

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
Waste Generation									

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
High-Level Waste (canisters)[e]	1	4,600	0	43[f]	5[f]	(g)	4,600	4,643	~4,600
Transuranic Waste (cubic meters)	2	17,100	0	100	10	65,000	82,100	82,200	~82,100
Low-Level Waste (cubic meters)	3	500,000	0	200	42	2,500,000	3,000,000	3,000,000	3,000,000
Low-Level Mixed Waste (cubic meters)	4	13,000	0	0	0	11,000,000	11,000,000	11,000,000	11,000,000
Saltstone (cubic meters)[h]	5	627,000	0	2,500	500	(g)	627,000	630,000	628,000
Offsite Population									
Collective dose, 10 years (person-rem)	6	68	0	0.38	0.062	686	754	754	754
Number of latent cancer fatalities from collective dose	7	0.034	0	0.00019	0.000031	0.34	0.37	0.37	0.37
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	8	0.14	0	0.0034	0.00057	9.8	9.9	9.9	9.9
Probability of a latent cancer fatality	9	7.0×10^{-8}	0	1.7×10^{-9}	2.9×10^{-10}	4.9×10^{-6}	5.0×10^{-6}	5.0×10^{-6}	5.0×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	6	8,400	0	469	76	8,309	16,700	17,200	16,800
Number of latent cancer fatalities from collective dose	10	3.4	0	0.19	0.030	3.3	6.7	6.9	6.7

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to defense waste processing (DOE 1994c); tritium supply and recycle (DOE 1995a); spent nuclear fuel management, including spent nuclear fuel from foreign research reactors (DOE 1995e); other site-specific waste management actions, including environmental restoration activities (DOE 1995d); F-Canyon (DOE 1994a); interim management of nuclear materials (DOE 1995b); storage and disposition of weapons-usable fissile materials (DOE 1996a); stockpile stewardship and management (DOE 1996b); and disposition of highly enriched uranium (DOE 1996c).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.17-2 of the Waste Management Programmatic EIS (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[f] Material managed as high-level waste.
[g] The waste generation due to other reasonably foreseeable future actions (20 years) is included in the column of waste generation due to existing operations.
[h] Although saltstone is a low-level waste, it is managed independently from other low-level wastes.

Notes:
(1) Data for existing operations from Table 1.6-2 of DOE 1997c.
(2) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-3 of DOE 1997c.
(3) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-1 of DOE 1997c.
(4) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-2 of DOE 1997c.
(5) Data for existing operations from Table 5-5 of DOE 1994a.
(6) Assumes all facilities operate concurrently for the same 10-year period.
(7) Assumes 0.0005 latent cancer fatalities per person-rem.
(8) Based on (DOE 1994e) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing residues and scrub alloy are received in 1 year.
(9) Assumes 5×10^{-7} latent cancer fatalities per mrem.
(10) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 4–96 Estimated Maximum Radiological Doses and Resulting Health Effects to Offsite Population and Workers Due to Other Reasonably Foreseeable Future Actions at the Savannah River Site

	Offsite Population		*Offsite Maximally Exposed Individual*		*Worker Population*	
Activity	*10-year Collective Dose (person-rem)*	*Latent Cancer Fatalities*	*Annual Dose (mrem)*	*Annual Fatal Cancer Risk*	*10-year Collective Dose (person-rem)*	*Latent Cancer Fatalities*
Management of Spent Nuclear Fuels (DOE 1995e)	184	0.092	0.5	2.5×10^{-7}	760	0.30
Tritium Supply and Recycling (DOE 1995a)	85	0.043	4.1	1.2×10^{-6}	163	0.065
F-Canyon Plutonium Solutions (DOE 1994a)	1.2	0.00060	0.0027	1.4×0^{-9}	475	0.19
Interim Management of Nuclear Materials (DOE 1994c)	220	0.11	0.56	2.8×10^{-5}	1,405	0.56
Defense Waste Processing Facility (DOE 1994c)	0.71	0.00036	0.0011	5.5×10^{-10}	1,180	0.47
Other Site-Specific Waste Management, including Environmental Restoration (DOE 1995d)	150	0.075	0.36	1.8×10^{-7}	1,440	0.58
Storage and Disposition of Weapons-Usable Fissile Materials (DOE 1996a)	0.00018	9.0×10^{-8}	0.000014	7.0×10^{-12}	250	0.10
Stockpile Stewardship and Management (DOE 1996b)	8.6	0.0043	0.32	1.6×10^{-7}	1,560	0.62
Disposition of Surplus Highly Enriched Uranium (DOE 1995c)	36.6	0.018	3.96	2.0×10^{-6}	1,076	0.43
Total	686	0.34	9.8	4.9×10^{-6}	8,309	3.3

Wastes—As shown in Table 4–95, existing operations at the Savannah River Site will generate large volumes of high-level waste, transuranic waste, low-level waste, low-level mixed waste, and saltstone. Table 4–95 also lists the volumes of these wastes that could be generated from the processing of plutonium residues and scrub alloy. These values are from Table 4–84 and are converted from number of drums to cubic meters when necessary. The limited processing of plutonium residues and scrub alloy at the Savannah River Site would cause very small increases in the wastes to be managed at this site.

Radiological Impacts—As identified in Table 4–95, the radioactive releases that would result from processing the Rocky Flats plutonium residues and scrub alloy at the Savannah River Site would not noticeably increase the radiation dose or the associated number of latent fatal cancers in the offsite population. Even with the conservative assumptions in this analysis, the radiation dose to the maximally exposed offsite individual would remain below the DOE regulatory limit of 10 mrem per year discussed in Section 4.25.1. The radiation dose to the involved worker population could increase by about 3 percent of the dose from existing operations and other reasonably foreseeable future actions over the 10-year processing periods. Doses to individual involved workers would be maintained below the limits discussed in Section 4.25.1.

Air Quality Impacts—The processing of plutonium residues and scrub alloy at the Savannah River Site would involve potential releases of nitrogen oxide, nitric acid, hydrogen fluoride, and phosphoric acid. The modeled offsite concentrations of these pollutants from Section 4.12 are presented in **Table 4–97**, along with site baseline concentrations (from Table 3–14) and concentrations from other onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at the Savannah River Site.

Because the total site concentrations are lower than the applicable standards, the cumulative impacts of the proposed action, the existing site baseline, and other onsite sources, should not be of concern with respect to air quality at the Savannah River Site. Ambient air concentrations based on monitoring data are discussed in Section 3.2.3. If these ambient air concentrations are combined with the concentrations in Table 4–97, the resulting concentrations would be below the air quality standards and guidelines. Note that combining the site's concentrations with the ambient concentrations is very conservative, as it is expected that the monitors would be impacted by Savannah River emission sources as well as any non-DOE sources. In addition, the State air quality agency does not require the site to add monitored concentrations to modeled concentrations for demonstrating compliance with the air quality standards (Savannah River Site, 1998).

Table 4–97 Cumulative Air Quality Impacts at the Savannah River Site

Pollutant	*Baseline Concentration ($\mu g/m^3$)*	*Modeled Concentration ($\mu g/m^3$)*	*Concentration from Other Onsite Sources*[a]	*Total Concentration ($\mu g/m^3$)*	*Averaging Time*	*Most Stringent Regulation or Guideline ($\mu g/m^3$)*[b]
Nitrogen Dioxide	8.8	0.039	3.6	12.4	Annual	100
Nitric Acid	50.96	0.65	4.76	56.37	24-hour	125
Hydrogen Fluoride	0.09 0.39 1.04 1.99	0.00036 0.0032 0.0032 0.0051	0.019 0.067 0.175 0.327	0.11 0.46 1.22 2.32	30-day 7-day 24-hour 12-hour	0.8 1.6 2.9 3.7
Phosphoric Acid	0.462	0.0016	0.0	0.464	24-hour	25

[a] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Savannah River based on the *Storage and Disposition of Weapons - Usable Fissile Materials Final PEIS*, (DOE 1996a).
[b] Federal and State standards.

4.25.3 Cumulative Impacts at Los Alamos National Laboratory

Aside from the continuation of existing operations and from the activities addressed in this EIS (limited to the processing of pyrochemical salt residues), reasonably foreseeable future actions at Los Alamos National Laboratory include construction and operation of the dual-axis hydrodynamic test facility (DOE 1995c), medical isotope production project (DOE 1996d), stockpile stewardship and management (DOE 1996b), and environmental restoration activities.

Wastes—As shown in **Table 4–98**, existing operations at Los Alamos National Laboratory will generate large volumes of transuranic waste, low-level waste, and low-level mixed waste. Table 4–98 also lists the volumes of these waste that could be generated from the processing of pyrochemical salts. These values are from Table 4–88 and are converted from number of drums to cubic meters when necessary. The limited processing of plutonium residues at Los Alamos National Laboratory would cause very small increases in the wastes to be managed at this site.

Table 4–98 Los Alamos National Laboratory Cumulative Radiological Impacts

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
Waste Generation									
Transuranic Waste (cubic meters)	1	10,800	0	600	200	4,400	15,200	15,800	15,400
Low-Level Waste (cubic meters)	2	150,000	0	1,300	400	325,000	475,000	476,000	475,000
Low-Level Mixed Waste (cubic meters)	3	2,770	0	0	0	980	3,750	3,750	3,750
Offsite Population									
Collective dose, 10 years (person-rem)	4	16	0	0.0024	0.00079	16.9	33	33	33
Number of latent cancer fatalities from collective dose	5	0.0079	0	1.2×10^{-6}	4.0×10^{-7}	0.0085	0.016	0.016	0.016
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	6	7.9	0	0.00080	0.00027	0.37	8.3	8.3	8.3
Probability of a latent cancer fatality	7	4.0×10^{-6}	0	4.0×10^{-10}	1.4×10^{-10}	1.9×10^{-7}	4.2×10^{-6}	4.2×10^{-6}	4.2×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	4	4,580	0	160	8.8	763	5,340	5,340	5,350
Number of latent cancer fatalities from collective dose	8	1.8	0	0.064	0.0035	0.31	2.1	2.2	2.1

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to dual-axis radiographic hydrodynamic test facility (DOE 1995c), medical isotope production (DOE 1996d), and stockpile stewardship and management (DOE 1996b).
[b] Impacts of existing operations, combined impacts from processing Rocky Flats pyrochemical salts, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.9-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).
[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats pyrochemical salts.
[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats pyrochemical salts.
Notes:
(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-3 of DOE 1997c.
(2) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-1 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.
(3) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-2 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.
(4) Assumes all facilities operate concurrently for the same 10-year period.
(5) Assumes 0.0005 latent cancer fatalities per person-rem.
(6) Based on (DOE 1994e) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing Rocky Flats pyrochemical salts are received in 1 year.
(7) Assumes 5×10^{-7} latent cancer fatalities per mrem.
(8) Assumes 0.0004 latent cancer fatalities per person-rem.

Radiological Impacts—As identified in Table 4–98, the radioactive releases that would result from processing the Rocky Flats pyrochemical salts at Los Alamos National Laboratory would cause very small increases in the radiation dose or the associated number of latent fatal cancers in the offsite population. The radiation dose to the maximally exposed offsite individual would remain below the DOE regulatory limit of 10 mrem per year as discussed in Section 4.2.5.1. The radiation dose to the involved worker population could increase by three percent of the dose from existing operations and other reasonably foreseeable future actions over the 10-year processing periods. Doses to individual involved workers would be maintained below the limits discussed in Section 4.25.1. **Table 4-99** shows the contributions to the cumulative impacts from specific reasonably foreseeable future actions.

Table 4–99 Estimated Maximum Radiological Doses and Resulting Health Effects to Offsite Population and Workers Due to Other Reasonably Foreseeable Future Actions at the Los Alamos National Laboratory

	Offsite Population		*Offsite Maximally Exposed Individual*		*Worker Population*	
Activity	*10-year Collective Dose (person-rem)*	*Latent Cancer Fatalities*	*Annual Dose (mrem)*	*Annual Fatal Cancer Risk*	*10-year Collective Dose (person-rem)*	*Latent Cancer Fatalities*
Dual-Axis Hydrodynamic Test Facility (DOE 1995c)	9.0	0.0045	0.02	1.0×10^{-8}	3.0	0.0012
Medical Isotope Production Project (DOE 1996d)	6.6	0.0033	0.15	7.5×10^{-8}	120	0.048
Stockpile Stewardship and Management (DOE 1996b)	1.3	0.00065	0.20	1.0×10^{-7}	640	0.26
Total	16.9	0.0085	0.37	1.9×10^{-7}	763	0.31

Air Quality Impacts—For the Los Alamos National Laboratory, the emissions of air pollutants from the processing of pyrochemical salts would be very small because only limited processing would take place at this site. In addition, the baseline concentrations of criteria air pollutants and hazardous air pollutants are much smaller than the applicable standards (see Table 3–21).

4.25.4 Cumulative Impacts of Intersite Transportation

The cumulative impacts from transportation of plutonium residues and scrub alloy from Rocky Flats to the Savannah River Site and Los Alamos National Laboratory are identified in Appendix E. Since likely transportation routes cross about nine States, cumulative impacts are computed on a national basis. Occupational radiation exposure to transportation workers and exposure to the public (from Section 4.24) would each increase by about 0.01 percent from the estimated cumulative exposure between 1943 and 2035 and would represent an estimated 0.1 percent of the cumulative exposure over the 10-year processing period. An additional traffic fatality is not expected (Section 4.24), and the incremental increase in traffic fatalities would be less than 0.0001 percent per year.

4.26 Relationship Between Short-Term Uses of the Environment and Long-Term Productivity

Implementation of any of the technologies for management of plutonium residues and scrub alloy currently stored at Rocky Flats would result in the short-term use of existing facilities and environmental resources. Facility modifications would be required for implementation of some of the offsite processing technologies such as mediated electrochemical oxidation at the Savannah River Site. However, none of the technologies would require the construction of new facilities. If offsite processing were selected for implementation, transportation of materials from Rocky Flats to any of the other candidate sites would occur on existing roadways. Estimates of the duration for the various alternatives range from less than 5 years to more than 20 years. Activities during that time would result in emissions to the atmosphere that would not measurably affect regional or global air quality. Although implementation of some of the processing technologies could impact the scheduled shut-down of Rocky Flats, short-term uses of the environment would have no appreciable beneficial or adverse effects on long-term productivity of the environment on, or in the vicinity of, any of the sites assessed in this EIS.

4.27 Irreversible and Irretrievable Commitment of Resources

All processing activities in this EIS would be conducted at existing facilities. Modifications to existing facilities would consist of improvements required to meet current environmental standards or the installation of new processing equipment. Materials required for the processing technologies, utilities, and fuel required for transportation options comprise the irretrievable resources required to implement the various options. Section 4.19 discusses these resources in detail. None of the alternatives require resources that would noticeably affect local or national supplies or that would noticeably affect the quality of the local or global environment.

4.28 Industrial Safety

The plutonium residues and scrub alloy would be processed at Rocky Flats, and additional processes may be performed at the Savannah River Site F-Canyon and F-B Line, the Savannah River Site H-Canyon and H-B Line, and the Los Alamos National Laboratory. Estimates of potential industry safety impacts to workers processing the residues and scrub alloy at these facilities were made using the average DOE occupational injury/illness and fatality rates shown in **Table 4-100** (DOE 1997g). The potential industrial safety impacts to the workers are presented in **Table 4-101**.

Table 4–100 Average Occupational Injury/Illness and Fatality Rates (per worker-year)

Category	*All Labor Categories (Process Operations)*	
	Total Injury/Illness	*Fatalities*
DOE and Contractors	0.032	0.000032
Private Industry	0.084	0.000097

Table 4–101 Industrial Safety Impacts from Processing Plutonium Residues and Scrub Alloy

Process Location	*Number of Injuries/Illnesses*	*Number of Fatalities*
Rocky Flats	12.5 to 77.0	0.013 to 0.077
Savannah River Site F-Canyon/F-B Line	0 to 14.1	0 to 0.014
Savannah River Site H-Canyon/H-B Line	0 to 32.8	0 to 0.033
Los Alamos National Laboratory	0 to 6.2	0 to 0.0062

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5. APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

Chapter 5 presents the laws, regulations, and other requirements that apply to the proposed action and alternatives. Federal, State, and departmental statutes, regulations, and orders are identified in Section 5.1. Regulations for hazardous and radioactive material packaging, transportation, and certification are discussed in Section 5.2. Emergency Management response laws and other requirements are addressed in Section 5.3.

5.1 LAWS AND OTHER REQUIREMENTS

This section describes laws, regulations, and Executive Orders that apply to the proposed action and alternatives. During the course of its activities, the Department of Energy (DOE) implements its responsibility for the protection of public health, safety, and the environment through compliance with laws, statutes, regulations, orders, and other requirements.

5.1.1 Federal Environmental Statutes and Regulations

Figure 5–1 illustrates the Federal regulations that are applicable. These statutes are summarized below.

- **National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.)—**This Act establishes a national policy to protect and preserve the environment. It requires consideration of environmental impacts during the planning and decision-making stages of Federal projects. It also requires Federal agencies to prepare a detailed statement on the environmental effects of proposed Federal actions that may significantly affect the quality of the human environment.

  Applicable implementing regulations for the NEPA include the Council on Environmental Quality Implementing Regulations (40 CFR 1500 et seq.) and DOE Implementing Regulations (10 CFR 1021).

- **Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.)—**This Act provides the underlying legal authority (originally vested in the Atomic Energy Commission, and now transferred to DOE) for government ownership and operation of nuclear facilities. As part of that authority, it authorizes the DOE to establish standards to protect health or minimize dangers to life or property with respect to activities under its jurisdiction. Under this authority, DOE has established a comprehensive system of safety standards and requirements.

  In addition, the Act provides the underlying authority for Nuclear Regulatory Commission regulations, and (through Reorganization Plan Number 3 of 1970) for Environmental Protection Agency (EPA) regulations to protect the general environment.

- **Pollution Prevention Act of 1990 (42 U.S.C. 13101 et seq.)—**This Act establishes a national policy for waste management and pollution control. Source reduction is given first preference, followed by environmentally safe recycling, with disposal or releases to the environment as a last resort. In response to the policies established by this act, the DOE committed to participation in the Superfund Amendments and Reauthorization Act, Section 313, EPA 33/50 Pollution Prevention Program. The goal for facilities involved in compliance with Section 313 is to achieve a 33 percent reduction (from a 1993 baseline) in the release of 17 priority chemicals by 1997.

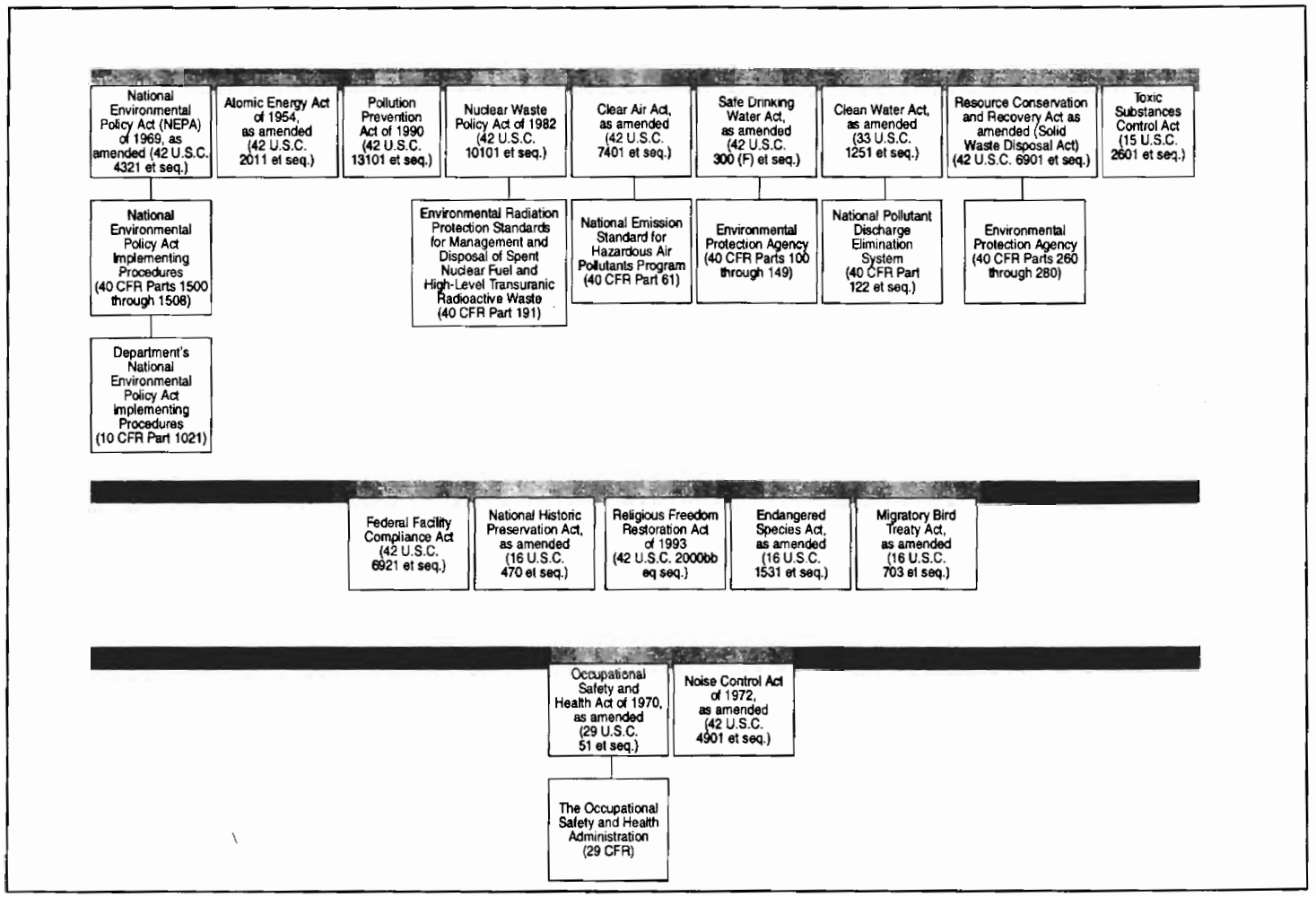

Figure 5–1 Federal Environmental Statutes and Regulations

On August 3, 1993, the President issued Executive Order 12856 requiring the DOE to achieve a 50 percent reduction in total releases of all toxic chemicals by December 31, 1999.

- **Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101 et seq.)—**This Act provides for research, development, and demonstration activities regarding disposal of high-level radioactive waste and spent nuclear fuel not resulting from defense activities. As originally enacted it called for the Secretary of Energy to recommend candidate repository sites; but in 1987 it was amended to require DOE to proceed with characterization of the Yucca Mountain Site only (42 U.S.C. 10133, 10172). The Act also established the Office of Civilian Radioactive Waste Management (OCRWM, 42 U.S.C. 10224), the Office of Nuclear Waste Negotiator (42 U.S.C. 10242), and the Nuclear Waste Fund (42 U.S.C. 10222); and it provides (along with the Atomic Energy Act) authority for the EPA standards for protection of the general environment from the management and disposal of spent nuclear fuel, high-level, and transuranic radioactive wastes (40 CFR 191).

- **Low Level Radioactive Waste Policy Act (42 U.S.C. 2021 et seq.)—**This Act (originally enacted in 1980, and subsequently amended) amended the Atomic Energy Act to specify that the Federal Government is responsible for disposal of low-level waste generated by its activities, and the States are responsible for disposal of other low-level waste. It provides for and encourages interstate compacts to carry out the State responsibilities.

- **Hazardous Material Transportation Act of 1975 (49 U.S.C. 5105 et seq.)—**This Act requires the Department of Transportation to prescribe uniform national regulations for transportation of hazardous materials (including radioactive materials). Most State and local regulations regarding such transportation that are not substantively the same as the Department of Transportation regulations are preempted (i.e., rendered void) (49 U.S.C. 5125). This, in effect, allows State and local governments only to enforce the Federal regulations—not to change or enlarge on them.

  This program is administered by the Research and Special Programs Administration of the Department of Transportation, which coordinates its regulations with those of the Nuclear Regulatory Commission (under the Atomic Energy Act) and with EPA (under the Resource Conservation and Recovery Act), when covering the same activities.

- **Clean Air Act (42 U.S.C. 7401 et seq.)—**This Act is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Clean Air Act (42 U.S.C. 7418) requires that each Federal agency with jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with "all Federal, State, interstate, and local requirements" with regard to the control and abatement of air pollution.

  The Act requires the EPA to establish National Ambient Air Quality Standards as necessary to protect public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 U.S.C. 7409); requires establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 U.S.C. 7411); requires specific emission increases to be evaluated so as to prevent a significant deterioration in air quality (42 U.S.C. 7470); and requires specific standards for releases of hazardous air pollutants (including radionuclides) (42 U.S.C. 7412). These standards are implemented through State implementation plans developed by each State with EPA approval. On July 18, 1997, the EPA issued its final rules establishing new ambient air standards for ozone and particulate matter. The new standards are described in Chapter 3 of this Environmental Impact Statement (EIS). These new rules became effective on September 16, 1997.

Air emissions are regulated by the EPA in 40 CFR Parts 50 through 99. Radionuclide emissions are regulated under the National Emission Standards for Hazardous Air Pollutants Program (40 CFR Part 61).

- **Safe Drinking Water Act of 1974 (42 U.S.C. 300 (F) et seq.)—**The primary objective of this Act is to protect the quality of the public drinking water systems and sources of drinking water. Implementing regulations, administered by the EPA unless delegated to the States, establish standards applicable to public water systems. These regulations include maximum contaminant levels (including those for radioactivity) in public water systems, which are defined as water systems that have at least 15 service connections or regularly serve at least 25 residents. Safe Drinking Water Act requirements have been published by the EPA in 40 CFR Parts 141 through 149.

  For radioactive material, the regulations specify that the average annual concentration of manmade radionuclides in drinking water as delivered to the user by such a system shall not produce a dose equivalent to the total body or an internal organ greater than four mrem/yr beta activity (40 CFR 141.16 (a)). Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

- **Clean Water Act of 1972 (33 U.S.C. 1251 et seq.)—**This Act, which amended the Federal Water Pollution Control Act, was enacted to "restore and maintain the chemical, physical and biological integrity of the Nation's water." The Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 of the Clean Water Act requires all branches of the Federal Government engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, State, interstate, and local requirements.

  The Clean Water Act provides for water quality standards for the Nation's waterways, guidelines and limitations for effluent discharges from point-source discharges, and the National Pollutant Discharge Elimination System permit program. The National Pollutant Discharge Elimination System program is administered by the Water Management Division of the EPA pursuant to regulations in 40 CFR Part 122 et seq.

  Sections 401 through 405 of the Water Quality Act of 1987 added Section 402(p) to the Clean Water Act, requiring that the EPA establish regulations for permits for storm water discharges associated with industrial activity. Stormwater provisions of the National Pollutant Discharge Elimination System program are set forth at 40 CFR 122.26.

- **Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (42 U.S.C. 6901 et seq.)—**The transportation, treatment, storage, or disposal of hazardous and nonhazardous waste is regulated under the Solid Waste Disposal Act of 1965, as amended by the Resource Conservation and Recovery Act in 1976 and the Hazardous and Solid Waste Amendments of 1984. Under Resource Conservation and Recovery Act, EPA defines and identifies hazardous wastes, establishes standards for its transportation, treatment, storage, and disposal, and requires permits for persons engaged in hazardous waste activities. Section 3006 of the Act (42 U.S.C. 6926) allows States to establish and administer those permit programs with EPA approval. The EPA regulations implementing the Resource Conservation and Recovery Act are found in 40 CFR Parts 260 through 283.

  Regulations imposed on a generator or a treatment, storage, and/or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, and/or disposed of. The method of treatment, storage, and/or disposal also impacts the extent and complexity of the requirements.

- **Federal Facility Compliance Act of 1992 (42 U.S.C. 6961 et seq.)—**This Act made all Resource Conservation and Recovery Act provisions, including fines and penalties for violations, applicable to Federal facilities by waiving sovereign immunity for such violations. However, Section 102© of the Act delayed that waiver (and therefore the liability for Resource Conservation and Recovery Act penalties) for three years for storage of mixed waste at Federal facilities, and continued that delay indefinitely for mixed waste storage at DOE facilities so long as DOE submits a plan for that storage for State or EPA approval and complies with a Consent Order incorporating the approved plan.

- **National Historic Preservation Act of 1996, as amended (16 U.S.C. 470 et seq.)—**This Act provides that sites with significant national historic value be placed on the *National Register of Historic Places* maintained by the Secretary of the Interior. No permits or certifications are required under the Act. However, if a particular Federal activity may impact a historic property resource, consultation with the Advisory Council on Historic Preservation is required by 16 U.S.C. 470 f. Such consultation usually generates a Memorandum of Agreement, including stipulations that must be followed to minimize adverse impacts. Coordination with the State Historic Preservation Officer is also undertaken to ensure that potentially significant sites are properly identified and appropriate mitigative actions are implemented.

- **Endangered Species Act (16 U.S.C. 1531 et seq.)—**This Act, enacted in 1973, is intended to prevent the further decline of endangered and threatened species and to restore these species and their habitats. Section 7 of the Act requires Federal agencies having reason to believe that a prospective action may affect an endangered or threatened species or its habitat to consult with the Department of the Interior to ensure that the action does not jeopardize the species or destroy its habitat. If, despite reasonable and prudent measures to avoid or minimize such impacts, the species or its habitat would be jeopardized by the action, a review process is specified to determine whether the action may proceed.

- **Occupational Safety and Health Act of 1970 (29 U.S.C. 651 et seq.)—**This Act establishes standards for safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration, a U.S. Department of Labor agency. Although the Occupational Safety and Health Administration and the EPA both have a mandate to reduce exposures to toxic substances, the Occupational Safety and Health Administration's jurisdiction is limited to safety and health conditions that exist in the workplace environment.

  Under the Act, it is the duty of each employer to furnish employees a place of employment free of recognized hazards likely to cause death or serious physical harm. Employees have a duty to comply with the occupational safety and health standards and all rules, regulations, and orders issued under the Act. The Occupational Safety and Health Administration regulations (29 CFR) establish specific standards telling employers what must be done to achieve a safe and healthful working environment. Government agencies, including DOE, are not technically subject to the Occupational Safety and Health Administration regulations; but are required (by 29 U.S.C. 668) to establish their own occupational safety and health programs for their places of employment which are consistent with the Occupational Safety and Health Administration standards. DOE does so through DOE Orders, standards that contractors must meet as applicable to their work at Government-owned, contractor-operated facilities (DOE Order 5480.1B, 5483.1A). DOE keeps and makes available the various records of minor illnesses, injuries, and work-related deaths as required by the Occupational Safety and Health Administration regulations.

- **Toxic Substances Control Act of 1976 (15 USC 2601 et seq.)—**The Toxic Substances Control Act provides the U.S. EPA with the authority to require testing of chemical substances entering the environment and to regulate them as necessary. The law complements and expands existing toxic substance laws, such as §112 of the Clean Air Act and §307 of the Clean Water Act. The Toxic Substances Control Act also

regulates the treatment, storage, and disposal of polychlorinated biphenyls, chlorofluorocarbons, asbestos, dioxins, certain metal-working fluids, and hexavalent chromium. Asbestos regulations under the Toxic Substances Control Act were ultimately overturned. However, regulations pertaining to asbestos removal, storage, and disposal are promulgated through the National Emission Standard for Hazardous Air Pollutants Program (40 CFR 61, Subpart M). For chlorofluorocarbons, Title VI of the Clean Air Act Amendments of 1990 requires a reduction of chlorofluorocarbons beginning in 1991, and prohibits production after the year 2000.

5.1.2 Executive Orders

Figure 5–2 illustrates the applicable Executive Orders. These orders are summarized as follows:

- **Executive Order 11514 (Protection and Enhancement of Environmental Quality)—**Executive Order 11514 requires Federal agencies to continually monitor and control their activities to protect and enhance the quality of the environment and to develop procedures to ensure the fullest practicable provision of timely public information and understanding of the Federal plans and programs with environmental impact into obtain the views of interested parties. DOE issued regulations (10 CFR Part 1021) and DOE Order 5440.1E for compliance with this Executive Order.

- **Executive Order 11593 (National Historic Preservation) (May 13, 1971)—** Executive Order 11593 directs Federal agencies to locate, inventory, and nominate properties under their jurisdiction or control to the *National Register of Historic Places* if those properties qualify. This process requires DOE to provide the Advisory Council on Historic Preservation the opportunity to comment on the possible impacts of the proposed activity on any potential eligible or listed resources.

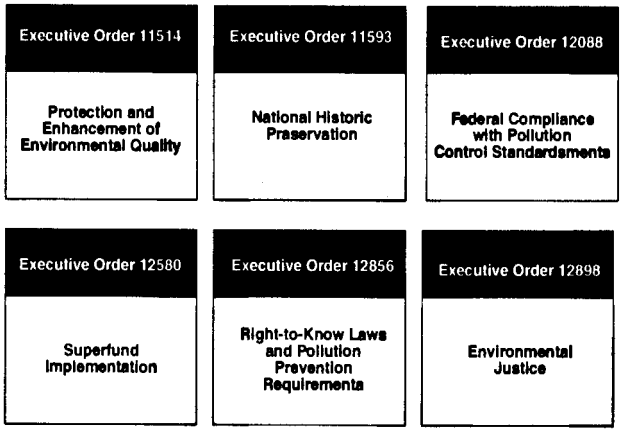

Figure 5–2 Executive Orders

- **Executive Order 12088 (Federal Compliance with Pollution Control Standards) (October 13, 1978), as amended by Executive Order 12580 (January 23, 1987) Federal Compliance with Pollution Control Standards—**Executive Order 12088 directs Federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act, the Noise Control Act, the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act (15 USC 2061 et seq.), and the Resource Conservation and Recovery Act.

- **Executive Order 12580 (Superfund Implementation)—**Executive Order 12580 delegates to the heads of executive departments and agencies the responsibility for undertaking remedial actions for releases, or threatened releases that are not on the National Priority List and removal actions other than emergencies where the release is from any facility under the jurisdiction or control of executive departments and agencies.

- **Executive Order 12856 (Right-to-Know Laws and Pollution Prevention Requirements)—**Executive Order 12856 requires all Federal agencies to reduce the toxic chemicals entering any waste stream. This Order also requires Federal agencies to report toxic chemicals entering waste streams; improve emergency planning, response, and accident notification; and encourage clean technologies and testing of innovative prevention technologies.

- **Executive Order 12898 (Environmental Justice)—**Executive Order 12898 requires Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

5.1.3 DOE Regulations and Orders

Through the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environmental program for its facilities. DOE Orders are issued in support of health, safety, and environmental programs. The major DOE Orders, notices, and standards pertaining to the proposed action and alternatives are listed in **Table 5–1**.

Table 5–1 Relevant DOE Orders, Notices, and Standards (as of February 4, 1997)

DOE Order/ Notice/Standard [a]	*Subject*
Orders	
Leadership/Management Planning	
O 151.1	Comprehensive Emergency Management System (9-25-95; Chg. 2, 8-21-96)
Information and Analysis	
O 231.1	Environment, Safety, and Health Reporting (9-30-95; Chg. 2, 11-07-96)
O 232.1	Occurrence Reporting and Processing of Operations Information (9-25-95; Chg. 2, 8-12-96)
Work Processes	
O 420.1	Facility Safety (10-3-95; Chg. 2, 10-24-96)
O 425.1	Startup and Restart of Nuclear Facilities (09-29-95); Chg. 1, 10-26-95
O 440.1	Worker Protection Management for DOE Federal and Contractor Employees (9-30-95; Chg. 1, 10-21-96)
O 451.1A	National Environmental Policy Act Compliance Program
O 460.1A	Packaging and Transportation Safety (10-2-96)
O 460.2	Departmental Materials Transportation and Packaging Management (9-27-95; Chg. 1, 10-26-95)
O 470.1	Safeguards and Security Program (9-28-95; Chg. 1, 6-21-96)
Management Systems and Standards	
1300.2A	DOE Technical Standards Program (5-19-92)
1360.2B	Unclassified Computer Security Program (5-18-92)
Personnel Relations and Services	
3790.1B	Federal Employee Occupation Safety and Health Program (1-7-93) [Canceled except for Chapter 8]
Real Property Management	
4330.4B	Maintenance Management Program (2-10-94)
Project Management	

DOE Order/ Notice/Standard [a]	***Subject***
4700.1	Project Management System (3-6-87; Chg. 1, 6-2-92)
Environmental Quality and Impact	
5400.1	General Environmental Protection Program (11-9-88; Chg. 1, 6-29-90)
5400.5	Radiation Protection of the Public and the Environment (2-8-90; Chg. 2, 1-7-93)
5480.1B	Environmental, Safety and Health Program for DOE Operations (9-23-86; Chg. 4, 3-27-90)
5480.18B	Nuclear Facility Training Accreditation Program (08-31-94)
5480.19	Conduct of Operations Requirements for DOE Facilities (7-9-90; Chg.1, 5-18-92)
5480.20A	Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities (11-15-94)
5480.21	Unreviewed Safety Questions (12-24-91)
5480.22	Technical Safety Requirements (2-25-92; Chg. 2, 1-23-96)
5480.23	Nuclear Safety Analysis Reports (4-10-92; Chg. 1, 3-10-94)
5480.27	Equipment Qualification for Reactor and Nonreactor Nuclear Facilities (1-15-93)
5480.4	Environmental Protection, Safety, and Health Protection Standards (5-15-84; Chg. 4, 1-7-93)
5480.6	Safety of Department of Energy-Owned Nuclear Reactors (9-23-86)
5482.1B	Environment, Safety, and Health Appraisal Program (9-23-86; Chg. 1, 11-18-91)
Emergency Preparedness	
5530.3	Radiological Assistance Program (1-14-92; Chg. 1, 4-10-92)
5530.5	Federal Radiological Monitoring and Assessment Center (7-10-92; Chg. 1, 12-2-92)
Defense Programs	
5610.14	Transportation Safeguards System Program Operations (5-12-93)
5633.3B	Control and Accountability of Nuclear Materials (9-7-1994)
5660.1B	Management of Nuclear Materials (5-26-1994)
Energy Programs and Policies—General	
5700.6C	Quality Assurance (8-21-91; Chg. 1, 5-10-96)
Energy Research and Technology	
5820.2A	Radioactive Waste Management (9-26-88)
Design	
6430.1A	General Design Criteria (4-6-89)
Notices	
N 251.4	Site Safety Representatives (09-29-95)
N 251.4	Safety Analysis and Review System (9-29-95)
N 251.6	Comprehensive Environmental Response, Compensation, and Liability Act Requirements (09-29-95)
N 441.1	Department of Energy Laboratory Accreditation Program for Personnel Dosimetry (09-30-95)
N 441.1	Radiation Protection for Occupational Workers (09-30-95)
Standards	
STD-3013-96	Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage (09-96; supersedes DOE-STD-3013-94)

[a] New DOE numbering system, by functional area; within 2 years, the numbering system for these orders will be converted to the new DOE numbering system (3 digit).

DOE regulations are found in 10 CFR. These regulations address areas such as energy conservation, administrative requirements and procedures, nuclear safety, and classified information. For the purposes of this EIS, relevant regulations and draft regulations include 10 CFR Part 834, Radiation Protection of the Public and the Environment; 10 CFR Part 835, Occupational Radiation Protection; 10 CFR Part 1021, Compliance with NEPA; and 10 CFR Part 1022, Compliance with Floodplains/Wetlands Environmental Review

Requirements. DOE has enacted occupational radiation protection standards to protect government and contractor employees. These standards are set forth in 10 CFR Part 835, Occupational Radiation Protection, which establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the activities conducted by DOE and its contractors. Activities may include, but are not limited to, design, construction, or operation of facilities. DOE Orders set forth policy and the programs and internal procedures for implementing those policies.

5.1.4 State Environmental Statutes and Regulations

Figure 5−3 illustrates agreements between the States and DOE relevant to the proposed action and alternatives. These agreements and compliance orders are summarized below.

Figure 5-3 Legal Agreements and Compliance Orders

5.1.4.1 The State of Colorado

Before 1989, management of plutonium residues and scrub alloy at the Rocky Flats Environmental Technology Site (Rocky Flats) was governed by the Atomic Energy Act. However, in 1989 the State of Colorado determined that a portion of the residues were mixed with hazardous waste and therefore subject to the Colorado Hazardous Waste Act (CRS 25-15-101 et seq.). The Colorado Department of Health and Environment has been delegated primary Resource Conservation and Recovery Act authority by the EPA, including permitting requirements. Activities associated with the mixed residues must comply with Colorado s hazardous and mixed waste generator, treatment, storage, disposal, and transportation requirements found in 6 Colorado Code of Regulations Chapter 1007, Article 3, Parts 99, 100, and 260-268. Currently, all of the mixed residues are in compliance with the Colorado Resource Conservation Act regulations. Along with the delegation of authority for Resource Conservation and Recovery, the EPA has delegated Clean Air Act and Clean Water Act authority to the State of Colorado.

The Colorado Air Quality Control Board has authority for air pollutants other than radioactive materials. Colorado submitted a State Implementation Plan that was approved by the EPA, that gives them primary permitting and enforcement authority. The governing regulations are found in the Colorado Air Pollution Prevention and Control Act implementing regulations, 5 Colorado Code of Regulations 1001. Of particular relevance to this EIS are Regulations No. 3 and No. 8. Regulation No. 3 requires Rocky Flats to file Air Pollutant Emission Notices to summarize nonradiological air emissions. Air Pollutant Emission Notices include an estimate of quantity and composition of air emissions generated from source operations. In addition to Air Pollutant Emission Notices, operating and construction air permits are required. Regulation No. 8 implements the Federal National Emission Standards for Hazardous Air Pollutants program for nonradioactive hazardous air pollutants in the State of Colorado. The Colorado Air Quality Control Board sets work standards, emission limitations, and ambient air standards for hazardous air pollutants. Colorado is in the process of gaining EPA approval of a radionuclide National Emission Standards for Hazardous Air Pollutants

program. The current EPA requirement limits the radiation dose to the public from airborne radionuclide emissions to 10 mrem/yr effective dose equivalent. Once Colorado obtains approval of its program, this standard could be more stringent for Rocky Flats.

The State of Colorado established the Colorado Water Quality Control Commission to implement the Federal National Pollutant Discharge Elimination System permit program, except for Federal facilities such as Rocky Flats. Consequently, although the Colorado Water Quality Control Commission sets the applicable effluent limitations for surface water quality that Rocky Flats must comply with, the EPA issues and administers National Pollutant Discharge Elimination System permitting. The State does ratify issuance of Federal permits and has the ability to veto the permit if it does not contain sufficient terms to protect all ambient segment water quality standards.

The Site was issued its original National Pollutant Discharge Elimination System permit in 1974 (#CO-0001333). The permit was reissued by the EPA in 1984, expired in 1989, and was modified and extended administratively by the National Pollutant Discharge Elimination System Federal Facility Compliance Agreement in March 1991. Key modifications included (1) eliminating two inactive discharge points and establishing new monitoring parameters for the other discharge locations, (2) changing one "point of compliance" location from Pond B-3 to the wastewater treatment plant, and (3) adding monitoring requirements for total chromium and whole effluent toxicity at terminal ponds A-4, B-5, and C-2 (the only ponds capable of discharging water offsite).

A revised, draft National Pollutant Discharge Elimination System permit (still in the draft stage as of 1996) was issued to the Site in February 1994. When finalized, this permit is expected to change the Site's discharge points to the wastewater treatment plant, Building 374 product water, and six storm water monitoring stations. Until the new permit is in effect, the terms and conditions of the existing National Pollutant Discharge Elimination System permit remain in effect. The draft National Pollutant Discharge Elimination System permit's monitoring requirements, sampling locations, analytical parameters, and sampling frequency details are not yet finalized.

The final permit is expected to apply numeric standards to wastewater treatment plant discharges. It is also expected to require implementation of "best management practices" for storm water. Storm water quality has a direct influence on Site pond water quality because storm water generally has high sediment loads that can carry contaminants into the ponds. Although the National Pollutant Discharge Elimination System permit has historically regulated discharges *from* the Site's detention ponds rather than *to* the ponds, the draft permit regulates wastewater treatment plant and storm water discharges from the developed portion of the Site *prior* to entering the A-, B-, and C-Series ponds. Storm water discharges would be regulated from six locations within the developed portion of the Site. The draft permit requires that existing best management practices for storm water continue to be implemented until the EPA approves the Site's *Stormwater Pollution Prevention Plan*.

The draft National Pollutant Discharge Elimination System permit is also expected to require that footing drain (e.g., building drain) discharges be monitored. Footing drain systems for buildings and structures in the Industrial Area are potential sources of contaminants for surface water at the Site. Water collected in the footing drains is discharged to storm sewers, sanitary sewers, building sumps, or surface outfalls and may reach Site ponds either through exfiltration of water from the sewers or through direct discharge to surface outfalls. Specific examples of footing drain flows that may affect Site ponds include outfalls for Buildings 317/ 374, 707, and 774. While the volume of water in the footing drains is not large compared to storm runoff, substantial concentrations of chemical contaminants could occur.

Water quality is tested at various discharge points and is compared against site-specific stream standards set by the Colorado Water Quality Control Commission. This dual compliance responsibility is based on the Site's status as a Federal facility. While the EPA has authorized the State of Colorado to implement the Federal National Pollutant Discharge Elimination System permit program for Colorado waters, the State's authority does not extend to Federal facilities such as the Site. Therefore, the EPA retains authority for issuing National Pollutant Discharge Elimination System permits for the Site. The State's authority derives primarily from the stipulation in the Clean Water Act that each State must certify that National Pollutant Discharge Elimination System permit conditions are consistent with its own water quality standards.

The respective roles and responsibilities of the EPA and the State of Colorado in regulating the quality of water onsite and offsite are clarified in the National Pollutant Discharge Elimination System Federal Facility Compliance Agreement (Section 6.5.11).

In March 1990, the Colorado Water Quality Control Commission adopted site-specific water quality standards in lieu of statewide standards for Woman Creek, Walnut Creek, Standley Lake, and Great Western Reservoir. The Commission determined that the site-specific standards were appropriate to establish extra protection for Great Western Reservoir and Standley Lake. As a result, specific stream standards for Woman Creek and Walnut Creek were adopted for organic and inorganic chemicals, metals, radionuclides, and certain physical and biological parameters. "Segment 4" standards adopted for tributaries downstream of the Site's detention ponds were more stringent than "Segment 5" standards adopted for tributaries upstream of these ponds.

In January and April 1995, the Commission issued additional revisions to the standards for Walnut Creek and Woman Creek drainages (e.g., resegmenting portions of Walnut Creek and eliminating the unionized ammonia standards for those segments). The EPA has not yet issued the National Pollutant Discharge Elimination System permit reflecting the Commission's water quality standards; however, the Site is abiding by them. Water is discharged from the Site only with the concurrence of the Colorado Department of Public Health and Environment.

The Colorado Water Quality Control Commission has established radionuclide standards for gross alpha, gross beta, plutonium, americium, tritium, and uranium that were not health-based but based, on existing ambient quality. DOE consistently claimed that the standards were too stringent and inconsistent with the statewide standard. As part of the Rocky Flats Cleanup Agreement (see Agreements), DOE, the EPA, and the Colorado Department of Health and Environment agreed to multiple action levels that will be proposed for approval to the Colorado Water Quality Control Commission, including a health-based standard for radionuclides.

The Colorado Water Quality Control Commission made the following rulings at its December 1996 rulemaking on water quality regulations affecting Rocky Flats: (1) repealed the site-specific radionuclide standard of 0.05 pCi/L and adopted a statewide standard of 0.15 pCi/L and (2) granted Rocky Flats a temporary modification of the nitrate standard to 100 mg/L (an increase from the existing 10 mg/L).

- **Agreements**—On November 3, 1989, DOE, the Colorado Department of Public Health and Environment, and the EPA signed the Mixed Residue Settlement Agreement and Compliance Order on Consent No. 89-10-30-01 to address the issue of alleged violations of the Resource Conservation and Recovery Act pertaining to proper waste management of mixed residues. The Sierra Club civil lawsuit was decided on August 13, 1991, whereby DOE was directed to either obtain a Resource Conservation and Recovery Act permit within two years for the existing inventory of mixed residues or suspend all Site operations generating mixed waste. As of February 7, 1995, the mixed residues are fully permitted and in compliance with the Colorado hazardous waste regulations. Although several subsequent judicial and administrative orders occurred, currently only one governs the residues. Consent No. 93-04-23-01 requires the

preparation of the Mixed Residue Reduction Report and that DOE process the backlog of mixed residues into shippable or disposable form as expeditiously as possible.

The Rocky Flats Cleanup Agreement, issued on July 19, 1996, is the legal document that identifies the relationship between DOE, the EPA, and the Colorado Department of Public Health and Environment during cleanup of the Site. The goal of the Agreement is to create a coordinated approach, using one set of consistent environmental requirements and a process for reaching specific decisions within targeted time frames. The document provides a legal framework for guiding individual cleanup and waste management decisions for environmental restoration without predetermining those decisions. The Rocky Flats Cleanup Agreement does not govern the management of special nuclear materials or residues, nor does it govern the management of building deactivation and decontamination as long as DOE has a mission for those facilities.

5.1.4.2 The State of South Carolina

Materials shipped from Rocky Flats to the Savannah River Site for treatment, storage, or disposal are required to comply with State of South Carolina laws and regulations. The hazardous waste component of mixed residues are regulated by the South Carolina Department of Health and Environmental Control Resource Conservation and Recovery Act implementing regulations R.61-79.260 through 270. The South Carolina Department of Health and Environmental Control currently does not have land disposal restriction waste authority; therefore, Federal standards would apply. In addition to hazardous waste requirements, South Carolina air and water standards would apply. The South Carolina Department of Health and Environmental Control has been delegated primary enforcement authority. Under the South Carolina Pollution Control Act, the South Carolina Department of Health and Environmental Control operates a permitting program for both air and water. Air permits include operating and construction permits. Furthermore, for facilities within South Carolina, the EPA has maintained authority over radionuclide emissions. The South Carolina Department of Health and Environmental Control has lead authority for regulating all other Clean Air Act hazardous air pollutants.

- **Agreements—**DOE, the EPA, and the South Carolina Department of Health and Environmental Control signed a Federal Facility Compliance Agreement to coordinate cleanup at the Savannah River Site. In addition, DOE and the EPA signed a Federal Facility Agreement regarding land disposal restriction of mixed waste at Savannah River Site. Among other things, the agreement requires Savannah River Site to provide status reports on construction and operation of various waste management facilities and to obtain permits for the construction and operation of additional facilities to meet DOE's needs for treatment of mixed waste.

5.1.4.3 The State of New Mexico

Management of residues and scrub alloy within the State of New Mexico is governed by the New Mexico Health and Environmental Department, Environmental Improvement Division. The New Mexico Environmental Improvement Division has responsibility for enforcement of compliance with the New Mexico Hazardous Waste Act, the New Mexico Water Quality Act, and the New Mexico Air Quality Control Act.

- **Agreements—**The Agreement for Consultation and Cooperation for Transuranic Waste was signed by the State of New Mexico and DOE on April 18, 1988. The agreement specifies the requirements for the packaging, labeling, and transportation of transuranic waste to the Waste Isolation Pilot Plant (WIPP). WIPP is one of the potential disposal sites for Rocky Flats transuranic and transuranic-mixed wastes.

5.2 REGULATIONS FOR RADIOACTIVE MATERIAL PACKAGING AND TRANSPORTATION

5.2.1 Nuclear Regulatory Commission Packaging Certification

Nuclear Regulatory Commission regulations applicable to the transportation of radioactive materials are found in 10 CFR Part 71, which includes detailed packaging design requirements and package certification testing requirements. Complete documentation of design and safety analysis and results of the required testing are submitted to the Nuclear Regulatory Commission to certify the package for use. Certification tests include: heat, physical drop onto an unyielding surface, water submersion, puncture by dropping package onto a steel bar, and gas tightness.

5.2.2 Hazardous and Radioactive Materials Transportation Regulations

Transportation of hazardous and radioactive materials, substances, and wastes is governed by Department of Transportation, Nuclear Regulatory Commission, and the EPA regulations. These regulations may be found in 49 CFR Parts 171 through 178, 49 CFR Parts 383 through 397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

Department of Transportation regulations contain requirements for identifying a material as hazardous or radioactive. These regulations interface with the Nuclear Regulatory Commission or the EPA regulations for identifying material, but the Department of Transportation hazardous material regulations govern the hazard communication (such as marking, hazard labeling, vehicle placarding, and emergency response telephone number) and shipping requirements (such as required entries on shipping papers or the EPA waste manifests).

The EPA regulations pertaining to hazardous waste transportation are found in 40 CFR Parts 262 and 265. These regulations address labeling and record keeping requirements, including the use of the EPA waste manifest, which is the required shipping paper for transporting Resource Conservation and Recovery Act regulated hazardous waste.

Transportation casks are subject to numerous inspections and tests (10 CFR 71.87). These tests are designed to ensure that the cask components are properly assembled and meet applicable safety requirements. Tests and inspections are clearly identified in the Safety Analysis Report for Packaging and/or the Certificate of Compliance for each cask. Casks are loaded and inspected by registered users in compliance with approved quality assurance programs. Operations involving the casks are conducted in compliance with 10 CFR 71.91. Reports of defects or accidental mishandling are submitted to the Nuclear Regulatory Commission.

- **Communications**—Proper communication, provided by labels, markings, placarding, and shipping papers or other documents, assists in ensuring safe preparation and handling of transportation casks. Labels (49 CFR 172.403) applied to the cask document the contents and the amount of radiation emanating from the cask exterior (transport index). The transport index lists the ionizing radiation level (in mrem/hr) at a distance of 1 m (3.3 ft) from the cask surface.

  In addition to the label requirements, markings (49 CFR Subpart D and 173.471) should be placed on the exterior of the cask to show the proper shipping name and the consignor and consignee in case the cask is separated from its original shipping documents (40 CFR 172.203). Transportation casks are required to be permanently marked with the designation "Type B," the owner's (or fabricator's) name and address, the Certificate of Compliance number, and the gross weight (10 CFR 71.83).

  Placards (49 CFR 172.500), which indicate the radioactive nature of the contents, are applied to the transport vehicle or freight container holding the transportation cask. In the United States, spent nuclear

fuel is a Highway Route Controlled Quantity that must be placarded according to 49 CFR 172.507. Each freight container must be placarded as required by 49 CFR Part 172 Subpart F of the Hazardous Materials Regulations [49 CFR 176.76(f)]. Placards provide the first responders to a traffic or transportation accident with initial information about the nature of the contents.

Shipping papers should have entries identifying the following: the name of the shipper, emergency response telephone number, description of the spent nuclear fuel, and the shipper's certificate as described in 49 CFR Part 172 Subpart C.

In addition, drivers of motor vehicles transporting spent nuclear fuel must have training in accordance with the requirements of 49 CFR 172.700. The training requirements include: familiarization with the regulations, emergency response information, and the spent nuclear fuel communication programs required by the Occupational Safety and Health Administration. Drivers are also required to have training on the procedures necessary for safe operation of the vehicle.

❒ **Ground Transport—**Overland shipments (by rail car or by truck) are regulated by a variety of the Department of Transportation and Nuclear Regulatory Commission regulations dealing with packaging, notification, escorts and communication. In addition, there are specific regulations for carriage by truck and carriage by rail.

A package shipped over land in exclusive-use closed transport vehicles may not exceed the following radiation levels as provided in 49 CFR 173.441(b):

200 mrem/hr on the external surface of the package unless the following conditions are met, in which case the limit is 1,000 mrem/hr:

- The shipment is made in a closed transport vehicle
- The package is secured within the vehicle so that its position remains fixed during transportation
- There are no loading or unloading operations between the beginning and the end of the transportation

200 mrem/hr at any point on the outer surface of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load (or enclosure if used), and on the lower external surface of the vehicle

10 mrem/hr at any point 2 m (6.6 ft) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 m (6.6 ft) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle)

2 mrem/hr in any normally occupied space.

The shipper of record must comply with the requirements of 10 CFR 71.5 and 73.37. Section 71.5 provides that all overland shipments must be in compliance with Department of Transportation and Nuclear Regulatory Commission regulations, which provide for security of irradiated reactor fuel.

5.3 EMERGENCY MANAGEMENT AND RESPONSE LAWS AND OTHER REQUIREMENTS

This section discusses laws and other requirements related to emergency management and response. Figures 5−4 through 5−6 in the following subsections illustrate statutes, regulations, and Executive Orders applicable to emergency management and response for the proposed action and alternatives.

5.3.1 Federal Statutes

Figure 5−4 illustrates Federal statutes applicable to emergency planning and response. Summaries of these documents follow the figure.

- **Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C. 11001 et seq.) (also known as SARA Title III)** This Act requires emergency planning and notice to communities and government agencies of the presence and release of specific chemicals. The EPA implements this Act under regulations found at 40 CFR Parts 355, 370, and 372. Under Subtitle A of this Act, Federal facilities provide various information (such as inventories of specific chemicals used or stored and releases that occur from these sites) to the State Emergency Response Commission and to the Local Emergency Planning Committee to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. Implementation of the provisions of this Act began voluntarily in 1987, and inventory and annual emissions reporting began in 1988. In addition, DOE requires compliance with Title III as a matter of DOE policy. The requirements for this Act were promulgated by the EPA in 40 CFR Parts 350 through 372.

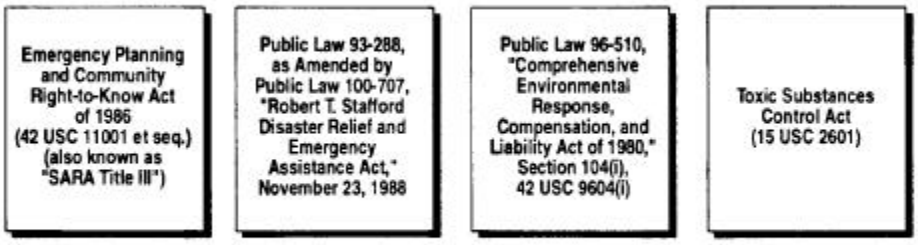

Figure 5−4 Federal Statutes Applicable to Emergency Management and Response

- **Public Law 93-288, as Amended by Public Law 100-707, Robert T. Stafford Disaster Relief and Emergency Assistance Act, November 23, 1988** This Act, as amended, provides an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage resulting from disasters. The President, in response to a State Governor s request, may declare an emergency or major disaster, to provide Federal assistance under the Act. The President, in Executive Order 12148, delegated all functions, except those in Sections 301, 401, and 409, to the Director, Federal Emergency Management Agency. The Act provides for the appointment of a Federal Coordinating Officer who will operate in the designated area with a State Coordinating Officer for the purpose of coordinating State and local disaster assistance efforts with those of the Federal Government.

- **Public Law 96-510, "Comprehensive Environmental Response, Compensation, and Liability Act of 1980," Section 104(I), 42 U.S.C. 9604(I)—**More popularly known as "Superfund," this Act provides the needed general authority for Federal and State governments to respond directly to hazardous substances incidents. The Act requires reporting of spills, including radioactive spills, to the National Response Center.

- **Public Law 98-473, Justice Assistance Act of 1984—**These Department of Justice regulations implement the Emergency Federal Law Enforcement Assistance functions vested in the Attorney General. Those functions were established to assist State and local governments in responding to a law enforcement emergency. The Act defines the term "law enforcement emergency" as an uncommon situation which requires law enforcement, which is or threatens to become of serious or epidemic proportions, and with respect to which State and local resources are inadequate to protect the lives and property of citizens, or to enforce the criminal law.

  Emergencies that are not of an ongoing or chronic nature, such as the Mount Saint Helens volcanic eruption, are eligible for Federal law enforcement assistance. Such assistance is defined as funds, equipment, training, intelligence information, and personnel. Requests for assistance must be submitted in writing to the Attorney General by the chief executive office of a State. The Plan does not cover the provision of law enforcement assistance. Such assistance will be provided in accordance with the regulations referred to in this paragraph [28 CFR Part 65, implementing the Justice Assistance Act of 1984] or pursuant to any other applicable authority of the Department of Justice.

5.3.2 Executive Orders

Figure 5–5 illustrates Executive Orders applicable to emergency management and response. Summaries of these Executive Orders follow the figure.

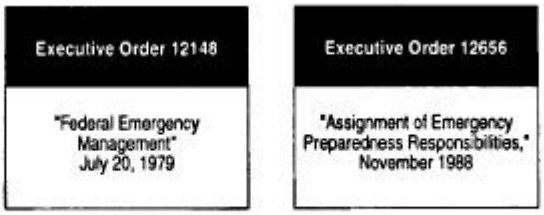

Figure 5-5 Executive Orders Applicable to Emergency Management and Response

- **Executive Order 12148, "Federal Emergency Management," July 20, 1979—**Executive Order 12148 transfers functions and responsibilities associated with Federal emergency management to the Director, Federal Emergency Management Agency. The Order assigns the Director, Federal Emergency Management Agency, the responsibility to establish Federal policies for and to coordinate all civil defense and civil emergency planning, management, mitigation, and assistance functions of Executive Agencies.

- **Executive Order 12656, "Assignment of Emergency Preparedness Responsibilities," November 1988—**Executive Order 12656 assigns emergency preparedness responsibilities to Federal departments and agencies.

5.3.3 Federal Regulations Concerning Emergency Management

Figure 5−6 illustrates Federal regulations applicable to emergency management and response. Summaries of these regulations follow the figure.

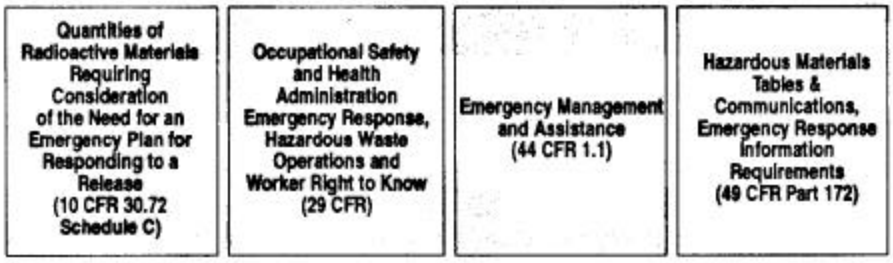

Figure 5-6 Federal Regulations Applicable to Emergency Management and Response

- **Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release (10 CFR 30.72 Schedule C)—**This list is the basis for both the public and private sector to determine if the radiological materials they deal with must have an emergency response plan for unscheduled releases, and is one of the threshold criteria documents for DOE Hazards Assessments required by DOE Order 5500.3A, "Planning and Preparedness for Operational Emergencies." "Federal Radiological Emergency Response Plan," November 1985−Primarily discusses offsite Federal response in support of State and local governments with jurisdiction during a peacetime radiological emergency.

- **Occupational Safety and Health Administration Emergency Response, Hazardous Waste Operations and Worker Right to Know (29 CFR)—**This regulation sets down the Occupational Safety and Health Administration requirements for employee safety in a variety of working environments. The regulation addresses employee emergency and fire prevention plans (Section 1910.38), hazardous waste operations and emergency response (Section 1910.120), and hazards communication (Section 1910.1200) that enables employees to be aware of the dangers they face from hazardous materials at their workplace.

- **Emergency Management and Assistance (44 CFR 1.1)—**This regulation contains the policies and procedures for the Federal Emergency Management Act, National Flood Insurance Program, Federal Crime Insurance Program, Fire Prevention and Control Program, Disaster Assistance Program, and Preparedness Program including radiological planning and preparedness.

- **Hazardous Materials Tables & Communications, Emergency Response Information Requirements (49 CFR Part 172)—**The regulatory requirements for marking, labeling, placarding, and documenting hazardous materials shipments are defined in this regulation. The regulation also specifies the requirements for providing hazardous material information and training.

5.3.4 Emergency Planning

During peacetime radiological emergencies that occur outside of Federal jurisdiction, Federal agencies support State and local governments with jurisdiction for the emergency. The *Federal Radiological Emergency Response Plan* of November 1985 describes the Federal government s concept of operations for this support. The plan outlines policies and planning assumptions that underlie the concept of operations. It also specifies authorities and responsibilities for those Federal agencies that play a significant role during an emergency.

6. LIST OF PREPARERS

CHARLES R. HEAD, DEPARTMENT OF ENERGY
EIS RESPONSIBILITIES: **DOE EIS PROJECT MANAGER**

Education:	M.S., Control Theory, George Washington University B.S., Electrical Engineering, Rice University
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PATRICK J. WELLS, DEPARTMENT OF ENERGY
EIS RESPONSIBILITIES: **DOE EIS DEPUTY PROJECT MANAGER**

Education:	M.S., Engineering Management, George Washington University B.S., Civil Engineering, Marquette University
Experience/ Technical Specialty:	Thirteen years. Occupational safety and health, oversight system acquisition, reliability, maintainability.

ARNOLD E. GUEVARA, DEPARTMENT OF ENERGY
***EIS RESPONSIBILITIES*:** **PROCESSING TECHNOLOGIES AND ALTERNATIVES**

Education:	M.S., Engineering Management, George Washington University B.S., Chemical Engineering, Tulane University
Experience/ Technical Specialty:	Sixteen years. Environmental restoration, project and policy analysis, nuclear materials management.

TRACY MUSTIN, DEPARTMENT OF ENERGY
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Experience/ Technical Specialty:	Sixteen years. Nuclear operations, nuclear materials management, environmental regulatory compliance.

ABE ZEITOUN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION (SAIC)
***EIS RESPONSIBILITIES*: SAIC PROJECT MANAGER, PURPOSE AND NEED, AND ALTERNATIVES**

Education: Ph.D., Environmental Sciences, Michigan State University
M.S., Fisheries, Michigan State University
B.S., Chemistry & Zoology, University of Alexandria

Experience/ Technical Specialty: Twenty-five years. Environmental regulatory compliance and assessments, social impacts, mitigation of adverse impacts.

D. JANE AARON, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: PROCESSING TECHNOLOGIES AND ALTERNATIVES**

Education: M.S., Environmental Policy and Management, University of Denver
B.S., Environmental Design, University of Colorado at Boulder

Experience/ Technical Specialty: Six years. Environmental regulatory compliance and analysis, environmental justice, cultural resource management.

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***EIS RESPONSIBILITIES*: PUBLIC SCOPING AND HEARINGS AND SUMMARY**

Education: B.S., Management and Technology, University of Maryland

Experience/ Technical Specialty: Twenty years. Nuclear and waste management policy analysis, technical writing, and communications.

RAKESH BAHADUR, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: ENVIRONMENTAL JUSTICE AND GEOGRAPHIC INFORMATION SYSTEMS (GIS)**

Education: Ph.D., Groundwater Hydrology, Colorado State University
M.S., Groundwater Hydrology, Colorado State University
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Experience/ Technical Specialty: Seventeen years. Hydrology, water pollution and hazardous waste management, site characterization, environmental assessment, risk assessment, modeling, high-resolution simulation.

LOUIS C. BORGHI, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: CHEMICAL CONSEQUENCES AND AFFECTED ENVIRONMENT**

Education: M.S., Ecology, Pennsylvania State University
B.A., Biology, LaSalle University

Experience/ Technical Specialty: Twenty years. Environmental fate, chemical risk assessment evaluations.

BURRUS M. CARNAHAN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: NONPROLIFERATION CONSEQUENCES**

Education: LL.M., International Law, University of Michigan
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B.A., Political Science, Drake University

Experience/ Technical Specialty: Nineteen years. Nuclear nonproliferation agreement negotiation and policies.

SYDEL CAVANAUGH, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: APPLICABLE REGULATIONS**

Education: B.A., Interdisciplinary Studies – Personnel/Sociology, University of Maryland

Experience/ Technical Specialty: Eleven years. Public participation, technical writing, and communications.

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***EIS RESPONSIBILITIES*: COSTS AND SOCIOECONOMICS**

Education: M.B.A., Marymount University
B.A., Economics, College of William & Mary

Experience/ Technical Specialty: Eighteen years. Energy economics, policy and regulatory analysis, socioeconomics, financial and economic analysis.

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***EIS RESPONSIBILITIES:* DESCRIPTION OF ALTERNATIVES AND PROCESSING TECHNOLOGIES, SAIC DEPUTY PROJECT MANAGER**

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M.B.A., Public Sector Management, Wharton Graduate School, University of Pennsylvania
M.A., Inorganic Chemistry, Duke University
A.B., Chemistry, Oberlin College

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Experience/ Technical Specialty: Sixteen years. Transportation risk analysis and reliability and safety engineering.

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***EIS RESPONSIBILITIES*: RESIDUES CHARACTERISTICS AND ALTERNATIVES**

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B.S., Nuclear Engineering, University of Virginia

Experience/ Technical Specialty: Fourteen years. Nuclear material production, waste isolation safety, plutonium disposition.

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***EIS RESPONSIBILITIES*: AIR QUALITY IMPACTS AND ASSESSMENTS**

Education: B.S., Meteorology from the Pennsylvania State University

Experience/ Technical Specialty: Twelve years. Air quality impacts and assessments.

FREDERICK R. HEARTY, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: RESPONSE TO PUBLIC INQUIRIES, RADIOLOGICAL ANALYSIS**

Education: M.S., Technology Management, State University of New York at Stony Brook
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Experience/ Technical Specialty: Twenty-five years. Nuclear facility operations, testing, startup, and maintenance planning.

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***EIS RESPONSIBILITIES*: PROCESSING TECHNOLOGIES AND ALTERNATIVES**

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Experience/ Technical Specialty: Twenty years. Waste disposal facility project management.

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***EIS RESPONSIBILITIES*: TRANSPORTATION AND EMERGENCY PLANNING**

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B.A., Economics, North Texas State University

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***EIS RESPONSIBILITIES*: CHEMICAL CONSEQUENCES**

Education: M.S., Environmental Engineering, University of Cincinnati
Bachelor of Technology, Mechanical Engineering, Indian Institute of Technology, Bombay, India

Experience/ Technical Specialty: Two years. Air quality modeling.

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Education: Sc.D., Nuclear Engineering, Massachusetts Institute of Technology
N.E., Nuclear Engineering, Massachusetts Institute of Technology
M.S., Nuclear Engineering, Massachusetts Institute of Technology
B.S., Chemical Engineering, Abadan Institute of Technology

Experience/ Technical Specialty: Twenty-one years. Nuclear powerplant safety, risk and reliability analysis, design analysis, criticality analysis, probabilistic risk assessment.

TODD MILLER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: IMPACT AND ACCIDENT ASSESSMENTS**

Education: M.C.E., Structural Engineering, The Catholic University of America
B.S., Civil Engineering, Worcester Polytechnic Institute

Experience/ Technical Specialty: Six years. Structural analysis, accident analysis, hazardous waste management and assessment, radiological assessments.

JOFU MISHIMA, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: RADIOLOGICAL AND ACCIDENT IMPACTS**

Education: B.S., Chemistry, Wayne University

Experience/ Technical Specialty: Forty-two years. Fractional airborne release of radionuclides, plutonium material behavior, plutonium storage safety issues, alternative plutonium shipping forms.

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***EIS RESPONSIBILITIES*: CHEMICAL CONSEQUENCES**

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Experience/ Technical Specialty: Nine years. Air quality modeling and GIS applications.

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Experience/ Technical Specialty: Eighteen years. GIS applications and computer simulation and mathematical modeling.

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Experience/ Technical Specialty: Twenty-one years. Hydrometallurgical extraction and purification operations, design and simulation of electrochemical synthesis, facility deactivation and decontamination.

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***EIS RESPONSIBILITIES*: DESCRIPTION OF ALTERNATIVES, PUBLIC HEARINGS, AND SUMMARY**

Education: B.A., Political Science, George Washington University

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***EIS RESPONSIBILITIES*: PROJECT ENGINEER, RADIOLOGICAL IMPACT ASSESSMENTS AND ACCIDENTS**

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***EIS RESPONSIBILITIES*: IMPACT ASSESSMENTS AND ALTERNATIVES**

Education:	Ph.D., Nuclear Engineering, University of Wisconsin M.S., Nuclear Engineering, University of Wisconsin B.S., Nuclear Engineering, Kansas State University
Experience/ Technical Specialty:	Seventeen years. Nuclear engineering, nuclear weapon design, nuclear materials production, nuclear weapon proliferation.

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Experience/ Technical Specialty:	Thirty-six years. Radiological impact assessment, safety analysis, facility accident analysis, risk-consequence analysis, design review.

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Education:	B.S., Chemical Engineering, University of Nevada
Experience/ Technical Specialty:	Thirteen years. Design and assessment of processing systems and equipment, system integration and analysis, technology selection and application.

GILBERT H. WALDMAN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
***EIS RESPONSIBILITIES*: RADIOLOGICAL IMPACT AND ACCIDENT ASSESSMENTS**

Education:	M.S. Engineering Candidate, Technical Management, Johns Hopkins University B.S., Nuclear Engineering, University of Florida
Experience/ Technical Specialty:	Seven years. Radiological impacts analysis, radiological dose modeling, radiological risk assessment.

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***EIS RESPONSIBILITIES*: RESIDUES CHARACTERISTICS AND PROCESSING TECHNOLOGIES**

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Experience/ Technical Specialty:	Forty-four years. Chemical processing of plutonium, research and development for processing plutonium, plutonium stabilization.

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Education:	Ph.D., Physics, New Mexico State University M.S., Physics, New Mexico State University B.S., Mathematics, North Texas State University
Experience/ Technical Specialty:	Twenty-four years. NEPA compliance, electromagnetic models, air quality modeling, ionizing radiation impacts and safety.

7. AGENCIES CONSULTED

FEDERAL AGENCIES

U.S. Census Bureau, Administrative and Customer Services Branch
U.S. Nuclear Regulatory Commission
U.S. Fish and Wildlife Service

STATE AGENCIES

California Agricultural Statistics Service, Estimation Branch
Colorado Department of Agriculture, Division of Markets
Colorado Department of Public Health and Environment, Emergency Management Program
Colorado State Patrol, Hazardous Material Section
Georgia Department of Natural Resources
Georgia Public Service Commission
Kansas Department of Agriculture
Kansas Department of Health and Environment
Kansas Division of Emergency Management
Kansas Highway Patrol
Kansas State Legislature
Missouri Department of Natural Resources, Environmental Emergency Response
Missouri State Highway Patrol
New Mexico Department of Agriculture, Office of Director/Secretary
South Carolina Budget and Control Board, Office of Research and Statistics, Health and Demographics
South Carolina Department of Health and Environmental Control
State of Colorado Demographic Section
State of Georgia Office of Planning and Budget
Tennessee Department of Environment and Conservation
Tennessee Emergency Management Agency

LOCAL AGENCIES

Aiken Department of Public Safety (South Carolina)
Atlanta Fire Department (Georgia)
City of Denver, Environmental Services (Colorado)
City of Hopkinsville Fire Department (Kentucky)
City of Kansas City, City Planning and Development (Missouri)
City of Kansas City, Environmental Management (Missouri)
City of Russell Fire Department (Kansas)
Colby Fire Department (Kansas)
Commercial Vehicle Enforcement (Tennessee)
Denver City Council (Colorado)
Ellis County Emergency Management (Kansas)

Flagler Fire Department (Colorado)

LOCAL AGENCIES (CONTINUED)

Hamilton County Sheriff's Department (Tennessee)
Jefferson County Sheriff's Department (Illinois)
Johnson County Emergency Management (Kansas)
Kansas City Fire Department (Missouri)
Kansas City Police Department, Commercial Vehicle Enforcement (Missouri)
Montgomery County Emergency Management Agency (Tennessee)
Mt. Vernon City Fire Department (Illinois)
Nashville Fire Department (Tennessee)
Russell County Emergency Management (Kansas)
Shawnee County Emergency Local Preparedness Committee (Kansas)
St. Clair County Sheriff's Department (Illinois)
St. Louis Department of Health and Hospitals (Missouri)
St. Louis Emergency Management Agency (Missouri)
St. Louis Emergency Services (Missouri)
St. Louis Fire Department (Missouri)

OTHER

Hays Fire and Inspection Services (Kansas)
National Agricultural Statistics Service (NASS), Colorado Agricultural Statistics
Southern States Energy Board (Georgia)
University of New Mexico, Bureau of Business and Economic Research, Data Bank
Urban Energy & Transportation Corporation (Washington, DC)
Westinghouse Electric Corporation, Governmental Affairs (New Mexico)
Wyondotte Company Emergency Management (Kansas)

8. GLOSSARY

***Abnormal transients*—**An unusual incident in which operating parameters affecting control of radioactive materials move out of the normal operating range.

***Absorbed dose*—**The energy deposited per unit mass by ionizing radiation. The unit of absorbed dose is the rad.

***Actinide*—**Any of a series of chemically similar, mostly synthetic, radioactive elements with atomic numbers ranging from actinium (89) through lawrencium (103).

***Acute exposure*—**A single exposure to a toxic substance that may result in severe biological harm or death. Acute exposures are usually characterized as lasting no longer than a day.

***Air quality standards*—**The prescribed quantity of pollutants in the air that cannot be exceeded legally during a specified time in a specified area.

***Alpha emitter*—**A radioactive substance that decays by releasing an alpha particle.

***Alpha particle*—**A particle consisting of two protons and two neutrons, given off by the decay of many elements, including uranium, plutonium, and radon. Alpha particles cannot penetrate a sheet of paper. However, alpha emitting isotopes in the body can be very damaging.

***Ambient air*—**The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures.

***Americium*—**A manmade element. Americium is a metal that is slightly heavier than lead. Americium-241 is produced by the radioactive decay of plutonium-241; in addition to being an alpha-emitter, it is an emitter of gamma rays. Americium-241 has a half-life of 433 years.

***Aquifer*—**A geologic formation that contains sufficient saturated permeable material to conduct groundwater and to yield worthwhile quantities of groundwater to wells and springs.

***As low as reasonably achievable (ALARA)*—**The approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit, but a process that has the objective of attaining doses as far below the applicable limits as is reasonably achievable.

***Ash residues*—**This category of residues includes incinerator ash; inorganics; sand, slag, and crucible; graphite fines; and firebrick. These residues are grouped together because of the similar methods in which the residues will be treated and/or repackaged.

***Atomic Energy Act (AEA)*—**A law originally enacted in 1946 and amended in 1954 that placed nuclear production and control of nuclear materials within a civilian agency, originally the Atomic Energy Commission. The Atomic Energy Commission was replaced by the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy.

***Atomic number*—**The number of positively charged protons in the nucleus of an atom or the number of electrons on an electrically neutral atom.

***Background radiation*—**Radiation from: (1) naturally occurring radioactive materials including radon, (2) cosmic sources, (3) global fallout as it exists in the environment (e.g., from the testing of nuclear explosive devices), and (4) consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.

***Beta emitter*—**A radioactive substance that decays by releasing a beta particle.

***Beta particle*—**A particle emitted in the radioactive decay of many radionuclides. A beta particle is identical to an electron. It has a short range in air and a small ability to penetrate other materials.

***Blend down*—**A process in which an appropriate material is added to a plutonium-bearing material to reduce the concentration of plutonium in the material. The quantity of plutonium in the material remains the same while the total quantity of material increases.

***Bounded*—**Producing the greatest consequences of any assessment of impacts associated with normal or abnormal operations.

***Button*—**Plutonium metal in a hemispherical shape, weighing approximately 1.8 kilograms (4 pounds).

***Calcination*—**A process in which a material is heated to a high temperature to drive off volatile matter (to remove organic material) or to effect changes (as oxidation or pulverization or to convert it to nodular form). Calciners and nodulizing kilns are considered to be similar units. The temperature is kept below the fusion point.

***Canister*—**A stainless-steel container in which nuclear material is sealed.

***Canyon*—**A heavily shielded building at the Savannah River Site used in the chemical processing of radioactive materials to recover special isotopes. Operation and maintenance are performed by remote control.

***Capable fault*—**A fault that has exhibited one or more of the following characteristics: (1) movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years; (2) macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault; (3) a structural relationship to a capable fault according to characteristics (1) or (2) above, such that movement on one could be reasonably expected to be accompanied by movement on the other.

***Cask*—**A heavily shielded massive container for holding nuclear materials during shipment.

***Cementation*—**A process in which cement and water are added to a plutonium-bearing material to create a concrete or grout material form.

***Ceramification*—**A process in which an inorganic oxide is heated at high temperatures to the point at which oxide particles begin to fuse together. This forms a ceramic material.

***Characterization*—**The determination of waste or residue composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done to determine appropriate storage, treatment, handling, transportation, and disposal requirements.

***Cold Ceramification*—**A process that stabilizes materials (e.g., residues) by converting them into chemically bonded phosphate ceramics.

***Collective dose*—**The sum of the total effective dose equivalents of all individuals in a specified population. Collective dose is expressed in units of person-rem.

***Committed effective dose equivalent*—**The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem, and will be accumulated during the 50 years following an intake of radioactive material into an individual's body. Used in cases when a person has an intake of radioactive material to denote that the dose is calculated for a period of 50 years following the intake. (See effective dose equivalent.)

***Community (environmental justice definition)*—**A group of people or a site within a spatial scope exposed to risks that potentially threaten health, ecology, or land values, or exposed to industry that stimulates unwanted noise, smell, industrial traffic, particulate matter, or other nonaesthetic impacts.

***Contact-handled waste*—**Packaged waste whose external surface dose rate does not exceed 200 mrem per hour.

***Contamination*—**The deposition of undesirable radioactive material on the surfaces of structures, areas, objects, or personnel.

***Criteria pollutants*—**Six air pollutants for which national ambient air quality standards are established by EPA: sulfur dioxide, nitric oxides, carbon monoxide, ozone, particulate matter less than or equal to 10 microns in diameter, and lead.

***Criticality*—**The conditions in which a system is capable of sustaining a nuclear chain reaction.

***Cultural resources*—**Archaeological sites, architectural features, traditional use areas, and Native American sacred sites.

***Cumulative impacts*—**The impacts on the environment that result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

***Curie*—**The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of the isotope radium-226. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

***Decay (radioactive)*—**Spontaneous disintegration of the nucleus of an unstable atom, resulting in the emission of particles and energy.

***Decommissioning*—**Retirement of a facility, including any necessary decontamination and/or dismantlement.

***Decontamination*—**Removal of unwanted radioactive or hazardous contamination by a chemical or mechanical process.

***Depleted uranium*—**Uranium that, through the process of enrichment, has been stripped of most of the uranium-235 it once contained, so that it has more uranium-238 than natural uranium. It is used as shielding, in some parts of nuclear weapons, and as a raw material for plutonium production.

***Digestion*—**A process that results in the destruction of an organic matrix by heating with an oxidizing acid such as nitric acid.

***Discounted dollars*—**The process of converting a dollar or a stream of dollars at some future date or dates to a single present value (the Net Present Value). The factor used to convert the stream is the discount rate, often called the weighted cost of capital.

***Dissolution*—**A process in which a material is dissolved. In this EIS, it refers to dissolving salts away from plutonium oxide. The material is first heated in air to convert any plutonium metal to plutonium oxide. Then the salt is dissolved away with water leaving plutonium oxide.

***DOE Orders*—**Requirements internal to the U.S. Department of Energy that establish DOE policy and procedures, including those for compliance with applicable laws.

***Dose (or radiation dose)*—**A generic term that means absorbed dose, effective dose equivalent, committed effective dose equivalent, or total effective dose equivalent as defined elsewhere in this glossary.

***Dose rate*—**The radiation dose delivered per unit time (e.g., rem per year).

***Ecology*—**The relationship of living things to each other and to the environment or the study of such relationships.

***Ecosystem*—**A complex of the community of living things and the environment forming a functioning whole in nature.

***Effective dose equivalent*—**The summation of the products of the dose equivalent received by specified tissues of the body and the appropriate weighting factors. It includes the dose from radiation sources internal and/or external to the body. The effective dose equivalent is expressed in units of rem.

***Effluent*—**A gas or liquid discharged into the environment.

***Endangered species*—**Animals, birds, fish, plants, or other living organisms threatened with extinction by manmade or natural changes in their environment. Requirements for declaring a species endangered are contained in the Endangered Species Act, as amended (16 U.S.C. 1531 et seq.), and in similar State laws.

***Enriched uranium*—**Uranium that has greater amounts of the isotope uranium-235 than occur naturally. Naturally occurring uranium is nominally 0.720 percent uranium-235.

***Environmental Impact Statement (EIS)*—**A document required of Federal agencies by NEPA for major Federal actions or legislation with potential for significantly affecting the environment. A tool for decisionmaking, it describes the potential impacts of the proposed and alternative actions.

***Environmental monitoring*—**The process of sampling and analysis of environmental media in and around a facility for the purpose of (1) determining compliance with performance objectives and (2) detection of environment contamination to facilitate timely remedial action.

***Epidemiology*—**The science concerned with the study of the causes, frequency, and distribution of disease, injury, and other health-related events in the human population.

***Escalation*—**A real increase in the price of a good or service, over and above the increase attributable to inflation.

***Fault*—**A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage of the earth's crust has occurred in the past.

***Fissile material*—**Any material fissionable by thermal (slow) neutrons; the two primary fissile isotopes are uranium-235 and plutonium-239.

***Fission*—**The splitting or breaking of a nucleus into at least two other nuclei and the release of a relatively large amount of energy. Two or three neutrons are usually released during this type of transformation.

***Fission products*—**The nuclei produced by fission of heavy elements, and their radioactive decay products.

***Fissionable material*—**Commonly used as a synonym for fissile material, the meaning of this term has been extended to include material that can be fissioned by fast neutrons, such as uranium-238.

***Frit*—**Finely ground glass used as feedstock input for vitrification.

***Ful Flo filter*—**A filter used to remove particulates that are 1 to 5 microns and larger, from liquid streams. The filter is packed with activated charcoal/graphite or fiberglass.

***Gamma ray*—**Very penetrating electromagnetic radiation of nuclear origin. Except for origin and energy level, identical to x-rays. Electromagnetic radiation frequently accompanying alpha and beta emissions as radioactive materials decay.

***Geologic repository*—**A place to dispose of radioactive waste deep beneath the earth's surface.

***Glovebox*—**Large enclosure that separates workers from equipment used to process hazardous material while allowing the workers to be in physical contact with the equipment; normally constructed of stainless steel with large acrylic/lead glass windows. Workers have access to equipment through the use of heavy-duty, lead-impregnated rubber gloves, the cuffs of which are sealed in portholes in the glovebox windows.

***Gray*—**A unit of absorbed dose (see Rad).

***Ground shine*—**The radiation dose received from radioactive material deposited on the ground's surface.

***Half-life*—**The time in which one-half of the atoms of a particular radioactive substance disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.

***Hazard index (HI)*—**A summation of the hazard quotient for all chemicals to be used at a given time at a site to yield cumulative levels for a site. An HI value of 1.0 or less means that no adverse human health effects (non-cancer) are expected to occur.

***Hazard quotient (HQ)*—**The value used as an assessment of non-cancer associated toxic effects of chemicals (e.g., kidney or liver dysfunction). It is independent of a cancer risk, which is calculated only for those chemicals identified as carcinogens.

***Hazardous material*—**A substance or material in a quantity and form that may pose an unreasonable risk to health and safety or property when transported in commerce.

***Hazardous substance*—**Any substance subject to the reporting and possible response provisions of the Clean Water Act, and the Comprehensive Environmental Response, Compensation, and Liability Act.

***Hazardous waste*—**Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

***High-efficiency particulate air (HEPA) filter*—**A filter with an efficiency of at least 99.95 percent used to remove particles from air exhaust streams prior to releasing to the atmosphere.

***High-level waste*—**The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include the highly radioactive material that the NRC, consistent with existing law, determines by rule requires permanent isolation.

***Immobilization*—**A process that converts plutonium-bearing material to a stable form for disposal.

***Inflation*—**A change in the nominal price level of all goods or services, unrelated to the real escalation of a particular good or service.

***Inorganic residues*—**This category includes all inorganic residues resulting from direct production operations.

***Isotopes*—**Different forms of the same chemical element that differ only by the number of neutrons in their nucleus. Most elements have more than one naturally occurring isotope. Many isotopes that do not exist in nature have been produced in reactors and particle accelerators.

***Lag Storage*—**Short-term storage for logistical reasons.

***Latent cancer fatalities (LCF)*—**Deaths occurring at later years from radiation-induced cancers.

***Levelization*—**Conversion of a stream of values that vary at a uniform rate over time to a constant value over the same period of time.

***Low enriched uranium (LEU)*—**Uranium enriched until it consists of up to 20 percent uranium-235. Used as nuclear reactor fuel.

***Low-income community*—**Low income populations in an affected area should be identified with the annual statistical poverty thresholds from the *Bureau of the Census Current Population Reports, Series P-60 on Income and Poverty*.

***Low-level waste* —**Any radioactive waste that is not spent fuel, high-level, or transuranic waste, and does not contain hazardous waste constituents.

***Management Approach*—**Refer to strategic management approach.

***Maximally exposed individual (MEI)*—**A hypothetical individual receiving the maximum exposure.

***Maximum contaminant level (MCL)*—**The maximum permissible levels of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Contaminants added to the water under the circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

***Mediated electrochemical oxidation (MEO)*—**A treatment process in which silver ions are used as catalysts to dissolve plutonium oxide and to destroy organic materials.

***Micron*—**One-millionth of a meter.

***Millirad (mrad)*—**One-thousandth of a rad.

***Millirem (mrem)*—**One-thousandth of a rem.

***Mitigate*—**To take practicable means to avoid or minimize the potentially harmful effects of an action (e.g., environmental harm from a selected alternative).

***Mixed Oxide (MOX)*—**A physical blend of uranium oxide and plutonium oxide which can be used as fuel in a nuclear reactor.

***Mixed waste*—**Waste that contains both "hazardous waste" and "radioactive waste" (as defined in this glossary).

***Muffle furnaces*—**Small (approximately 1 cubic foot) oven-like electrically-heated units, lined with refractory material, which can be used to heat material placed onto trays inserted into the unit.

***National Environmental Policy Act (NEPA)*—**A Federal law, enacted in 1970, that requires the Federal Government to consider the environmental impacts of, and alternatives to, major proposed actions in its decisionmaking processes. Commonly referred to by its acronym, NEPA.

***Natural phenomena accidents*—**Accidents that are initiated by phenomena such as earthquakes, tornadoes, floods, etc.

***Net present value*—**The value of a series of future income and expense streams brought forward to the present at the discount rate.

***Neutron*—**An uncharged elementary particle with a mass slightly greater than that of the proton. Neutrons are found in the nucleus of every atom heavier than hydrogen-1.

***Nonproliferation*—**Efforts to prevent or slow the spread of nuclear weapons and the materials and technologies used to produce them.

***Normal operation*—**All normal conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency greater than 0.1 events per year.

***Nuclear weapon*—**Any weapon in which the explosion results from the energy released by reactions involving atomic nuclei.

***Nuclide*—**A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

***Package*—**For radioactive materials, the packaging together with its radioactive contents as presented for transport (the packaging plus the radioactive contents is the package).

***Packaging*—**For radioactive materials, it may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shock to ensure compliance with U.S. Department of Transportation regulations.

***Pipe and Go*—**A term used to describe the repackaging (without further processing) of certain ash and pyrochemical salts into pipe components and then drums, followed by shipment of these loaded drums to WIPP.

***Plume immersion*—**Occurs when an individual is enveloped by a cloud of radioactive gaseous effluent and receives an external radiation dose.

***Plutonium*—**A manmade fissile element. Pure plutonium is a silvery metal that is heavier (for a given volume) than lead. Material rich in the plutonium-239 isotope is preferred for manufacturing nuclear weapons. Plutonium-239 has a half-life of 24,000 years.

***Plutonium residues*—**Material containing plutonium that was generated during the separation and purification of plutonium or during the manufacture of plutonium-bearing components for nuclear weapons.

***Population dose*—**See collective dose.

***Probable maximum flood*—**The largest flood for which there is any reasonable expectancy in a specific area. The probable maximum flood is normally several times larger than the largest flood of record.

***Process*—**Any method or technique designed to change the physical or chemical character of the residue or scrub alloy to render them less hazardous, safer to transport, store or dispose of, and/or less attractive for theft.

***Processing Option*—**A specific technology (e.g., vitrification, water leach, Purex) that can be used to process a particular category of plutonium residues or scrub alloy (e.g., ash, salt, scrub alloy).

***Purex*—**An acronym for Plutonium-Uranium Extraction, the name of the chemical process usually used to remove plutonium and uranium from spent nuclear fuel, irradiated targets, and other nuclear materials. As used in this EIS, the PUREX process is used to separate out plutonium from residues or scrub alloy.

***Pyro-oxidation*—**A process in which sodium carbonate is heated with a plutonium-bearing salt matrix to a high temperature to convert any reactive metals in the matrix to nonreactive oxides.

***Pyrophoric*—**Pyrophoric liquids are any liquids that ignite spontaneously in dry or moist air at or below 54.4 degrees Centigrade (130 degrees Fahrenheit). A pyrophoric solid is any solid material, other than one classed as an explosive, which under normal conditions is liable to cause fires through friction, retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious transportation, handling, or disposal hazard. Included are spontaneously combustible and water-reactive materials.

***Rad*—**A unit of absorbed dose. It corresponds to an energy absorption of 100 ergs per gram in any medium (1 rad = 0.01 gray).

***Radiation (ionizing)*—**Energy transferred through space or other media in the form of particles or waves. In this document, we refer to ionizing radiation that is capable of breaking up atoms or molecules. The splitting, or decay, of unstable atoms emits ionizing radiation.

***Radioactive waste*—**Waste that is managed for its radioactive content; solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended and of negligible economic value considering costs of recovery.

***Radioactivity*—**The spontaneous emission of radiation from the nucleus of an atom. Radionuclides lose particles and energy through this process of radioactive decay.

***Radioisotopes*—**Radioactive nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons.

***Radionuclide*—**A radioactive element characterized according to its atomic mass and atomic number that can be manmade or naturally occurring.

***Raschig (glass) rings*—**These residues originated from Process Vent Scrubber Systems and in plutonium solutions processing production tanks. The rings are small, hollow, borosilicate glass cylinders that are used to absorb neutrons and thus prevent criticality in the aforementioned production tanks. These rings are coated with insoluble plutonium compounds.

***Record of Decision (ROD)*—**A document prepared in accordance with the requirements of 40 CFR 1505.2 and 10 CFR 1021.315 that provides a concise public record of DOE's decision on a proposed action for which an EIS was prepared. A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative, factors balanced by DOE in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and, if not, why they were not.

***Region of influence*—**Region in which the principal direct and indirect socioeconomic effects of actions are likely to occur and are expected to be of consequence for local jurisdictions.

***Regulated substances*—**A general term used to refer to materials other than radionuclides that may be regulated by other applicable Federal, State, (or possibly local) requirements.

***rem (Roentgen Equivalent Man)*—**A unit of radiation dose. Dose in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, distribution factor and any other necessary modifying factors (1 rem = 0.01 sievert).

***Repackage*—**A process in which some residue materials may be removed from their current packaging containers and placed in new containers for improved safe secure storage or to meet packaging requirements for shipment.

***Resource Conservation and Recovery Act (RCRA) as Amended*—**The statute or law that establishes, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

***Risk*—**Expression of an impact that considers both the probability of that impact occurring and the consequences of the impact if it does occur.

***Risk assessment (chemical or radiological)*—**The qualitative and/or quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific chemical or radiological pollutants.

***Safe, secure trailer (SST)*—**A specially designed semitrailer, pulled by a specially designed tractor, that is used for the safe, secure transportation of cargo containing nuclear weapons or special nuclear material.

***Safeguards termination limit (STL)*—**Concentrations of plutonium in materials (by weight percent), above which the material would be attractive as a source of plutonium.

***Salt distillation*—**A process that separates transuranic materials from a salt matrix by distilling the salt away from any metal oxides present in the salt.

***Salt scrub*—**A process used to recover plutonium from salt residues. The salt is heated with a mixture of aluminum and magnesium. The magnesium reacts with plutonium chloride in the salt to form plutonium metal, which forms an alloy with the aluminum called scrub alloy.

***Saltstone*—**Low-radioactivity fraction of high-level waste formed into a concrete block at the Savannah River Site.

***Scoping*—**Process involving the solicitation of comments from interested persons, groups, and agencies at public meetings, public workshops, in writing, electronically, or via fax, to assist DOE in defining the proposed action, identifying alternatives, and developing preliminary issues to be addressed in an EIS.

***Scrub alloy*—**A magnesium/aluminum/americium/plutonium metal mixture that was created as an interim step in plutonium recovery.

***Seismicity*—**The tendency for the occurrence of earthquakes.

***Severe accident*—**An accident with a frequency rate of less than 10^{-6} per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, offsite consequences, or both.

***Shredding*—**A process in which materials are cut into small pieces, which have a combined surface area larger than the original materials.

***Sievert*—**A unit of radiation dose (1 sievert = 100 rem).

***Slope factor*—**An upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upper-level bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

***Sonic wash*—**A process that uses sound waves to agitate an aqueous slurry of contaminated materials. It helps to remove plutonium compounds more efficiently from the surface of the contaminated materials.

***Source term*—**The estimated quantities of radionuclides or chemical pollutants released to the environment.

***Special nuclear material (SNM)*—**Plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Nuclear Regulatory Commission, pursuant to the provisions of the Atomic Energy Act of 1954, Section 51, determines to be special nuclear material.

***Spent fuel standard*—**A term, coined by the National Academy of Sciences and modified by DOE, meaning that alternatives for the disposition of surplus weapons-usable plutonium should seek to make this plutonium roughly as inaccessible and unattractive for weapons use as the much larger and growing stock of plutonium in civilian spent nuclear fuel.

***Stabilized plutonium residues*—**As used in this EIS, these are plutonium residues that have been processed to change their physical, chemical or biological character or composition to allow their safe interim storage, but would contain plutonium concentrations in excess of safeguards termination limits. Under Alternative 4, these residues would be disposed at WIPP as transuranic waste.

***Stabilized residues*—**Plutonium residues that have been processed to make them chemically stable.

***Strategic Management Approach*—**The compilation of a complete set of processing options (one option for each residue category and for scrub alloy) which allows a specific management criterion to be met (e.g., least overall processing cost, processing with maximum plutonium separation). For completeness and to allow comparisons among management approaches, the eight management approaches evaluated in this EIS include No Action and the preferred management approach.

***Total effective dose equivalent*—**The sum of the effective dose equivalent from external exposures and the committed effective dose equivalent from internal exposures.

***Transuranic*—**Any element whose atomic number is higher than that of uranium (that is, atomic number 92). All transuranic elements are produced artificially and are radioactive.

***Transuranic waste*—**Waste contaminated with alpha-emitting radionuclides with half-lives greater than 20 years and concentrations greater than 100 nanocuries/gram at time of assay.

***Type B packaging*—**Packaging for radioactive material that meets the standards for Type A packaging and, in addition, meets the standards for the hypothetical accident conditions of transport as prescribed in 49 Code of Federal Regulations Part 173.398(c).

***Type B shipping cask*—**An NRC-certified cask with a protective covering that contains and shields radioactive materials, dissipates heat, prevents damage to the contents, and prevents criticality during normal shipment and accident conditions. It is used for transport of highly radioactive materials, and is tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

***Undiscounted dollars*—**Expressing income and expenditures in the year they occur, not at some common point in time.

***Uranium*—**The basic material for nuclear technology. It is a slightly radioactive naturally occurring heavy metal that is more dense than lead. Uranium is 40 times more common than silver.

***Variance (from safeguards termination limits)*—**Removal of requirements for strict material control and accountability as special nuclear material when evaluations demonstrate that the proposed processing method for the material, the controls in place for normal handling of transuranic waste from the processing, and the limited quantity of special nuclear material present at any particular place and time preclude the need to take additional measures to address threats of diversion and theft.

***Vitrification*—**For the purpose of this EIS, vitrification means a process that uses glass to encapsulate or agglomerate the plutonium contained in residues or scrub alloy in order to immobilize it.

***Vulnerabilities*—**Conditions or weaknesses that may lead to radiation exposure to the public, unnecessary or increased exposure to the workers, or release of radioactive materials to the environment.

***Waste Acceptance Criteria (WAC)*—**The requirements specifying the characteristics of waste and waste packaging acceptable to a disposal facility and the documents and processes the generator needs to certify that waste meets applicable requirements.

***Waste classification*—**Wastes are classified according to DOE Order 5820.2A, "Radioactive Waste Management," and include high-level waste, transuranic waste, and low-level waste.

***Waste Isolation Pilot Plant (WIPP)*—**A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet in operation.

***Waste management*—**The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated surveillance and maintenance activities.

***Waste minimization*—**An action that avoids or reduces the generation of waste by source or toxicity reduction, improves energy usage, or recycles.

***Waste classification*—**Wastes are classified according to DOE Order 5820.2A, Radioactive Waste Management, and include high-level waste, transuranic waste, and low-level waste.

***Water leach*—**A process that uses water to selectively dissolve the soluble portion of salt away from the material (e.g., plutonium) that is contained within it.

***WIPP WAC*—**Performance based waste acceptance criteria that must be met to allow disposal at the Waste Isolation Pilot Plant (refer to "Waste Acceptance Criteria" and Waste Isolation Pilot Plant," given above).

9. OVERVIEW OF THE PUBLIC PARTICIPATION PROCESS

This chapter summarizes the public comments received on this Environmental Impact Statement (EIS). The sub-chapters address the following:

Public Scoping for this EIS

Workshops for State and Local Officials Along Potential Transportation Routes Public Comments on the Draft EIS

Public Comments on the Draft EIS

- *Written Comments* (summary and full text with DOE responses)
- *Environmental Protection Agency Rating of Draft EIS*
- *Public Hearing Comments (summary and DOE responses)*

In addition to summarizing public comments received on the Draft EIS, Section 9.5 also includes a reproduction of all of the written comments, a more detailed identification of oral comments from public comment hearings, and DOE's responses to each comment.

9.1 PUBLIC SCOPING FOR THIS EIS

On November 19, 1996, DOE published in the Federal Register a Notice of Intent to prepare this EIS ("Notice of Intent to Prepare an Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site," 61 FR 58866). This notice identified the preliminary scope of the EIS and invited public comments on the preliminary alternatives identified for preparing certain Rocky Flats plutonium residues and scrub alloy for disposal or other disposition.

The alternatives in the Notice of Intent were identified as follows:

Alternative 1 - No Action (same as in this Final EIS),
Alternative 2 - Onsite Treatment (with and without plutonium separation), and
Alternative 3 - Offsite Treatment (with and without plutonium separation).

DOE conducted the public scoping process from November 19, 1996, to December 19, 1996, but continued to accept all comments received beyond the closing date. During the scoping period, two public scoping meetings were held - one at Rocky Flats on December 3, 1996, and one near the Savannah River Site (in North Augusta, South Carolina) on December 12, 1996. Comments were received from individuals at these scoping meetings. In addition, DOE received written comments from 30 organizations and individuals. Copies of all written comments and summaries of comments made at the public scoping meetings are kept on file at DOE Headquarters in Washington, D.C., and in public reading rooms identified on the map in **Figure 9-1** and in Chapter 7 of the Summary.

Almost half of the public scoping comments were from individuals and organizations in the Rocky Flats area (including a coalition of organizations with a specific interest in Rocky Flats activities), and most of the

remainder were from individuals and organizations in the Savannah River Site area (including the Savannah River Site's Citizens Advisory Board). A few were from national organizations.

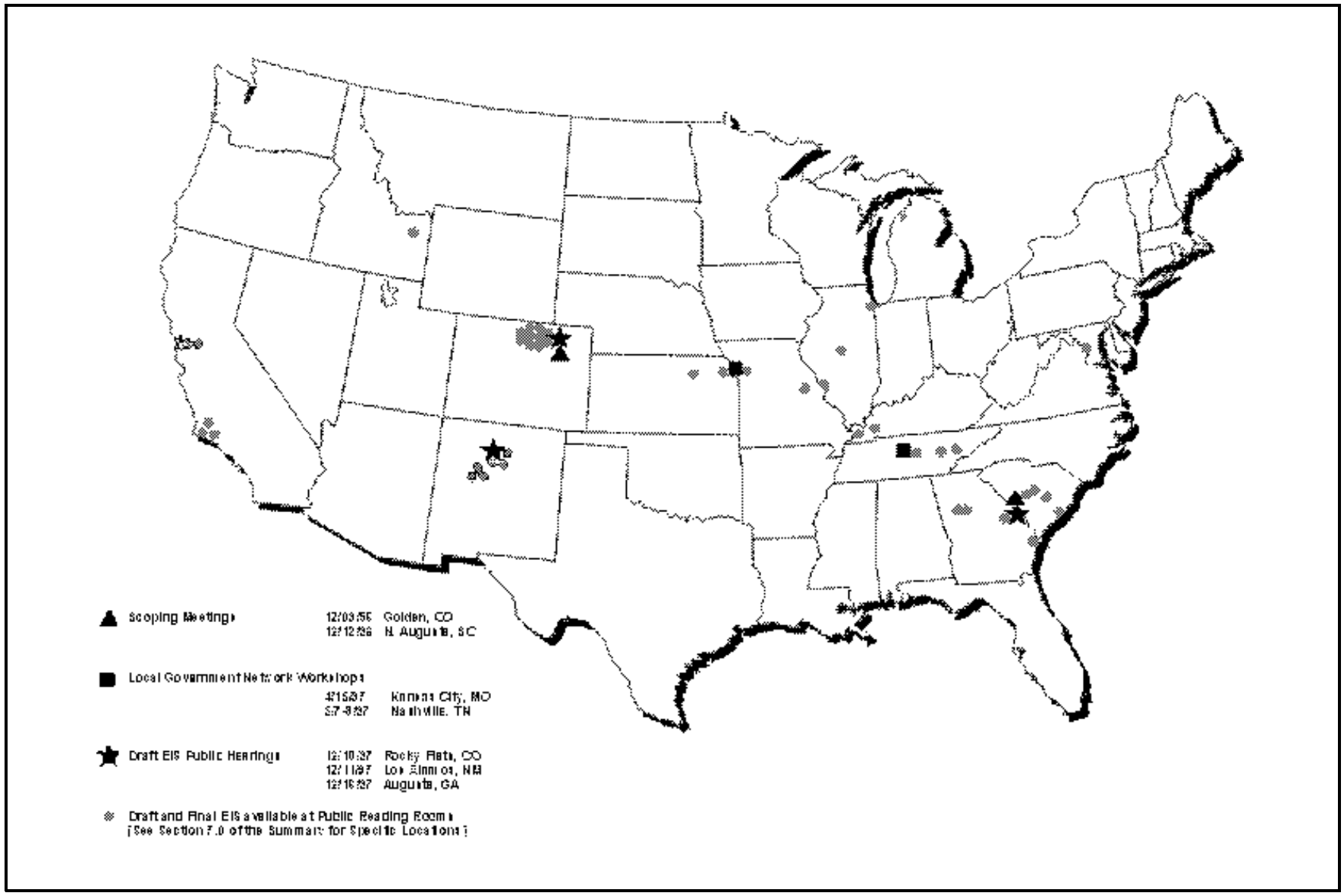

Figure 9-1 Location of Hearings, Workshops, and Public Reading Rooms

Most of the scoping comments included positions for or against the management alternatives presented in the Notice of Intent. No scoping comments were received on processing at Los Alamos National Laboratory or Lawrence Livermore National Laboratory, which were sites also considered in Alternative 3 (the latter site has since been dropped from consideration as an alternative). In providing these comments on the alternatives, specific comments were provided on related issues dealing with the following:

- Storage of the stabilized or processed materials
- Ultimate disposition of the stabilized or processed materials (e.g., Waste Isolation Pilot Plant (WIPP) disposal, mixed oxide fuel)
- Proliferation
- Transportation
- Environment, safety, and health risks
- Costs

A more detailed summary of the public scoping comments is presented in the November 1997 Draft EIS (see Section 9.3).

9.2 WORKSHOPS FOR STATE AND LOCAL OFFICIALS ALONG POTENTIAL TRANSPORTATION ROUTES

Prior to publication of the Draft EIS, DOE held workshops with the Local Government Network (composed of emergency response personnel and State and local officials along DOE transportation corridors). The workshops took place as follows:

- Kansas City, MO, April 16-17, 1997
- Nashville, TN, May 7-8, 1997

About 80 individuals participated in these workshops, during which DOE provided an overview of the upcoming Draft EIS, identified the potential shipments that could take place if a decision were reached to process the materials offsite, discussed the nature of the materials that could be shipped and the transport system that would be used for the shipments (e.g., the Safe Secure Trailer and the Type B shipping containers), and obtained feedback from the workshop attendees on their issues of concern. In addition to the question/answer sessions, the workshops included smaller break-out sessions that allowed participants to focus more in-depth on particular areas of interest. Meeting summaries from these two workshops are available in the DOE Reading Rooms identified in Chapter 7 of this Summary. Key suggestions and comments from those workshops include the following:

- Improve methods for making local citizens and officials more aware of the upcoming shipments (i.e., improve the distribution of information, such as widening the distribution list, using local PBS affiliates or radio stations to advertise and moderate public meetings, making the EIS available on a web page, distributing an information package, etc.).

- Provide more information on the shipment casks and Safe Secure Trailer system, including ongoing research, past history of shipments, amounts and nature of material inside the casks, truck and trailer sizes, and radiological monitoring.

- Share Safe Secure Trailer procedures with local government officials and emergency response personnel.

- Involve state and local government officials in developing the transportation plans for these shipments, including working out details ahead of time on issues such as safe parking and bad weather protocols; provide advance notifications.

- Improve coordination and funding for training of states and local officials in emergency response and provide the necessary equipment; enhance use of mutual aid agreements.

Following these workshops, DOE prepared a fact sheet on the potential plutonium residue shipments, which included information on the shipping casks and the Safe Secure Trailer, and distributed several copies of the fact sheet to the attendees at this meeting. The attendees volunteered at the workshops to distribute the fact sheets within their communities (e.g., media outlets and libraries). An updated version of this fact sheet is included in Appendix A of the Final EIS. In addition, DOE provided updates on this EIS at subsequent Local Government Network meetings.

9.3 ISSUANCE OF THE DRAFT EIS

In developing the Draft EIS, DOE considered the various scoping comments and presented analyses that addressed many of the concerns or questions. DOE also identified the criteria used to screen the various alternatives considered since scoping. The presentation of the alternatives in the Draft EIS was modified from the Notice of Intent as follows: Alternative 2 was modified to include only processing without plutonium separation, which would be conducted at Rocky Flats. Alternative 3 was modified to include Rocky Flats as a candidate site for processing with plutonium separation and to eliminate Lawrence Livermore National Laboratory as a candidate processing site. Alternative 3 was also modified to only consider processing with plutonium separation. Preferred processing technologies were identified for most of the material categories and subcategories in the Draft EIS.

The Environmental Protection Agency announced the availability of the Draft EIS in the Federal Register on November 21, 1997 (62 FR 62303). In addition, DOE mailed copies of the full Draft EIS and/or the Summary to over 1,000 individuals and organizations who were on DOE's mailing list (from previous requests) or who specifically requested copies during or after the comment period. The public had access to a toll-free number (1-800-736-3282) directed to the DOE Office of Environmental Management's Center for Environmental Management Information in order to request copies of the Summary or full EIS.

The public comment period was held from November 25, 1997, to January 5, 1998. However, DOE continued to accept and consider comments received after the closing date.

9.4 SUMMARY OF PUBLIC COMMENTS ON THE DRAFT EIS

This section summarizes the key comments DOE received on the Draft EIS, both in writing and orally (at public meetings). Key changes made to this EIS since publication of the Draft EIS, in response to public comments and further evaluations, are summarized in Chapter 1. Section 9.5 includes the full text of all written comments and identifies the oral comments received at the public hearings, along with DOE's responses.

9.4.1 Summary of Written Comments on the Draft EIS

Written submissions were received from 39 individuals and organizations. Of those

- 15 were from representatives of environmental, citizen, or business organizations.
- 10 were from State agencies.
- 5 were from Federal agencies.

- 7 were from individuals.
- 2 were from Cities.

The localities represented by the written submissions were as follows:

- 13 were from individuals or organizations in the Savannah River Site area; however, 7 of them were acknowledgments of receipt/no comment from South Carolina state agencies.
- 11 were from the Rocky Flats area.
- 8 were from the Los Alamos area.
- 4 were from those along transportation corridors.
- 3 were national in representation.

Most commentors provided their positions on the alternatives and processes (many of which addressed plutonium separation processes), provided specific comments on the analyses presented in the EIS, and identified concerns regarding associated issues such as storage; ultimate disposition; proliferation risks; transportation; environmental, safety and health risks; and costs.

Of the 39 written submissions (received by U.S. mail and E-mail), close to 200 specific comments were delineated (see Section 9.5). Key comments are summarized below (along with summaries of DOE responses) and are organized according to the following key issue areas:

- Alternatives or Processes
- Storage
- Ultimate Disposition
- Proliferation Risks
- Transportation
- Environmental, Safety and Health Risks
- Costs
- Other (miscellaneous).

❒ **Comments on Alternatives and Processes—**Most of those who provided comments indicated their support for or opposition to a particular alternative or process, along with their reasons. Reasons dealt with issues such as proliferation risk, worker exposures, transportation, storage, ultimate disposition, increase in waste volume, and cost (these are further summarized in the sections following).

Alternative 1 - No Action -- Stabilize and Store (Rocky Flats)

Very few commentors stated a preference for the No Action Alternative, which would stabilize the plutonium residues and scrub alloy for interim storage at Rocky Flats. Those who did suggested that the materials be stabilized and stored at Rocky Flats until safer treatment and disposal methods can be developed. While not stated explicitly, most of the commentors did not support this alternative. Instead, they advocated one of the other alternatives or variations to those alternatives (e.g., other processing technologies).

In response to these comments, DOE has expanded Sections 1.1, 1.2, and 1.3 of the Final EIS to better clarify that the alternatives evaluated under the Proposed Action would not only stabilize the plutonium residues and scrub alloy to address immediate health and safety concerns raised by the Defense

Nuclear Facilities Safety Board, but would also convert them into forms that would allow for their disposal or other disposition, thus eliminating health and safety concerns associated with indefinite storage of these materials. The No Action Alternative would not eliminate the long-term health and safety concerns. Nevertheless, DOE is required by the regulations implementing the National Environmental Policy Act to include evaluation of a No Action Alternative in the EIS. DOE has also responded individually to each comment related to the No Action Alternative in Section 9.5 of the Final EIS.

Alternative 2 - Processing without Plutonium Separation (Rocky Flats)

Commentors were split on their positions regarding the implementation of this alternative at Rocky Flats. Comments supporting processing at Rocky Flats included the following reasons and suggestions:

- Alternative 2 is preferred because of opposition to plutonium separation and transportation of such materials.
- Rocky Flats has the capabilities to do all of the required stabilization and processing.
- DOE should minimize the number of processes, or use "one-step" processes.
- DOE should use only those technologies that are mature and have been demonstrated.

Comments against processing at Rocky Flats included the following reasons and suggestions:

- DOE has committed to clean up and close Rocky Flats.
- Rocky Flats has old and unsafe facilities, which lack an "authorization basis" to process.
- Any process that would result in airborne releases at Rocky Flats is not acceptable.
- DOE has better facilities at the Savannah River Site.
- It is more cost-effective to use large-scale and proven facilities at the Savannah River Site.
- DOE should evaluate sites, other than those identified, that have vitrification capabilities.

In response to these comments, DOE notes that Section 2.9 of the Final EIS provides DOE's rationale for selecting processing technologies (for each material category) for evaluation in this EIS and for the Preferred Alternative. The Preferred Alternative is described in Section 2.5 of the Final EIS. The only processing technology at Rocky Flats identified under Alternative 2 for the Preferred Alternative is blend-down of certain filter media residues (Ful-Flo filters).

In selecting processing technologies for evaluation under Alternative 2, DOE eliminated all sites from consideration except Rocky Flats. The costs and risks of preprocessing (which would be required prior to transport of the materials to another site for processing), transportation, and final processing would exceed that of final processing at Rocky Flats without providing any tangible benefits.

As described in Section 1.3.1 of the Final EIS, DOE has added Alternative 4, Combination of Processing Technologies, to specifically address those materials for which a variance from safeguards

termination limits has been granted. The Preferred Alternative described in Section 2.5 of the Final EIS identifies those materials for which Alternative 4 is part of the Preferred Alternative.

DOE has also responded individually to each comment related to processing technologies without plutonium separation in Section 9.5 of the Final EIS.

Alternative 3 - Processing with Plutonium Separation (Rocky Flats, Savannah River Site, and Los Alamos National Laboratory)

About one-third of the commentors expressed strong opposition to shipment of the Rocky Flats residues and scrub alloy to either the Savannah River Site or Los Alamos National Laboratory for plutonium separation processes. Comments included the following reasons and suggestions:

- The proliferation risk would be greater if plutonium is separated during processing.
- Due to risks of accidents, these materials should not be transported.
- It is unnecessary to ship offsite - processing can be done at Rocky Flats.
- The separation process would result in a larger volume of waste than from nonseparation processes.
- DOE would be extending the life of the already aging canyons if processing with plutonium separation were to be chosen at Savannah River Site.
- DOE underestimated the costs of using the canyons.
- Separated plutonium should not be used as mixed oxide fuel in civilian nuclear powerplants.

Other commentors supported plutonium separation (some were directed specifically to plutonium separation at the Savannah River Site) because of the following reasons:

- The Savannah River Site has proven capabilities and is the only large-scale processing facility in the country.
- There is better security at the Savannah River Site and Los Alamos National Laboratory than at Rocky Flats.
- There is urgency to get the materials out of Rocky Flats so that the site can be closed.
- Processing at Savannah River Site would be more cost-effective.
- Plutonium has economic value (as an energy source).
- Separating plutonium and its disposition constitutes waste minimization.

Some commentors expressed concern about the feasibility of the salt distillation process at Los Alamos, stating that:

- The salt distillation process is not mature enough to be considered a preferred alternative.

- Los Alamos does not have capability to store the resulting americium-contaminated plutonium materials.

In response to these comments, DOE notes that Section 2.4 of the Final EIS provides DOE's rationale for selecting processing technologies (for each material category) for evaluation in this EIS and for the Preferred Alternative. The Preferred Alternative is described in Section 2.5 of the Final EIS. The only processing technologies under Alternative 3 identified for the Preferred Alternative are the Purex process at the Savannah River Site for certain ash residues (sand, slag and crucible), plutonium fluoride residues, and scrub alloy; and acid dissolution/plutonium oxide recovery at Los Alamos National Laboratory for certain (high assay) direct oxide reduction salts (these salts have two processing technologies under the Preferred Alternative -- the other is repackaging at Rocky Flats).

A major consideration in evaluating the potential use of the Savannah River Site canyons for processing a limited quantity of plutonium residues and scrub alloy is that the materials would be handled remotely, resulting in low worker radiation exposures. The canyons have been maintained and upgraded during their life cycle to ensure continued operability. Furthermore, they are currently operating, demonstrating their ability to safely process nuclear materials. Processing the materials under the Preferred Alternative, described in Section 2.5.2 of the Final EIS, would not require extending the operating life of the canyons as these facilities would be processing other previously-scheduled materials. As described in Section 2.5.2 of the Final EIS, salt distillation is no longer part of the preferred alternative. DOE has also responded individually to each comment related to processing technologies involving plutonium separation in Section 9.5 of the Final EIS.

Other Processing Options Not in Draft EIS

Some commentors expressed their beliefs that none of the processing options identified in the Draft EIS were reasonable and offered suggestions for additional options. These included:

- DOE should vitrify to meet the "spent fuel standard" in small "cans-in-canisters" or a "large monolith" at Rocky Flats.

- Small, mobile units should be used to conduct immobilization activities - they could be used at multiple sites.

Other commentors suggested that the EIS be delayed in order to more thoroughly evaluate other alternatives or the EIS should provide more rationale on why these are not being considered. Specific suggestions include the following:

- DOE should delay this EIS until more evaluation is done on innovative technologies, such as the Glass Material Oxidation and Dissolution System being developed at Oak Ridge National Laboratory or the cold ceramification immobilization process being developed at the Idaho National Engineering and Environmental Laboratory. These innovative technologies could be demonstrated on a small scale at Rocky Flats.

- DOE should include more sites in the EIS evaluation.

In response to these comments, DOE notes that the technology and site screening process is described in Section 2.9.2 of this Final EIS. Issues raised during the public scoping process that are not analyzed in the EIS are described in Section 2.9.3 of the Final EIS. DOE has also responded individually to each comment related to other processing options not in the Draft EIS in Section 9.5 of the Final EIS.

❒ **Comments Related to Storage—**A number of commentors addressed storage in their comments. Comments included the following:

- Continued storage at Rocky Flats is unacceptable (health and safety risks).
- DOE should evaluate contingency storage in the event of delays in opening the WIPP.
- DOE did not adequately address impacts of long-term storage under the No Action alternative in the EIS.
- The materials should stay in storage (following stabilization or processing) at Rocky Flats "for the time being" and not be transported to another site.
- Stored plutonium resulting from plutonium separation poses proliferation risks.
- DOE should address the amount of americium-contaminated wastes that would result from the salt distillation process, as well as low-level waste, at Los Alamos National Laboratory and how these wastes would be stored or disposed.
- The public needs to be ensured that the processed materials at Los Alamos will not be stored indefinitely at that site.
- Separated plutonium from processes at the Savannah River Site canyons could be adequately accommodated in the new Actinide Packaging and Storage Facility.

In response to these comments, DOE has revised its evaluation of the No Action Alternative (Alternative 1) to explicitly analyze the impacts from continued storage of the stabilized residues and scrub alloy at Rocky Flats until a decision is made concerning their ultimate disposition. A storage period of 20 years was used for the purpose of analysis. A discussion of storage has been added to Sections 2.3, 2.4 and 2.5.1 of this Final EIS, and the associated impacts have been added to Sections 4.2 through 4.11. For the other alternatives, a discussion of storage of processed material has been added to Section 4.14 of the Final EIS to address the possibility of WIPP not opening in the near future.

The analysis of storing any plutonium that would be separated during processing of salts at Los Alamos National Laboratory is contained in Sections 2.4.2.3 and 4.14 of the Final EIS. Under the Preferred Alternative, described in Section 2.5 of the Final EIS, the plutonium that would be separated during the processing of salts would not be contaminated with americium. The americium would go into the transuranic waste. DOE has also responded individually to each comment related to storage in Section 9.5 of the Final EIS.

❒ **Comments Related to Ultimate Disposition—**A number of commentors expressed concern about DOE's reliance on WIPP to dispose of the processed or stabilized residues. Key comments included the following:

- DOE is relying too heavily on WIPP, which is unlikely to open on schedule or may never open (some commentors cited specific problems with WIPP as a safe disposal facility).
- WIPP's compliance certification application with the Environmental Protection Agency (EPA) (and EPA's certification authority) does not cover the amounts and concentrations of plutonium addressed

in the materials covered by this EIS that would be shipped to WIPP. DOE should clearly address the number of shipments, amounts of processed residues and scrub alloy, and plutonium/americium concentrations that would be going to WIPP under this EIS and whether variances would be required.

Some of the commentors who opposed plutonium separation also provided the following comment:

- Separated plutonium should not be used in making mixed oxide fuel for civilian nuclear power plants due to proliferation risks.

In response to these comments, DOE notes that, in January 1998, DOE issued a Record of Decision regarding alternatives evaluated in DOE's Waste Isolation Pilot Plant Disposal Phase Final Supplemental EIS (discussed in Section 1.5.4 of the Final EIS) to dispose of transuranic waste at WIPP. Nevertheless, the decision to open WIPP is outside the scope of this EIS. Section 4.14 of the Final EIS addresses the impacts from storing processed residues in the event that WIPP does not open on schedule.

In addition, in July 1998, DOE published a Draft EIS on Surplus Plutonium Disposition (discussed in Section 1.5.7 of the Final EIS). The disposition of any plutonium separated from Rocky Flats plutonium residues and scrub alloy would be determined in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS. Any plutonium that would be separated under any alternative evaluated in this EIS would be immobilized. DOE has also responded individually to each comment related to ultimate disposition in Section 9.5 of the Final EIS.

❒ **Comments Related to Proliferation Risks—**Perceived proliferation risks were the primary reasons commentors did not support Alternative 3 - Processing with Plutonium Separation. Comments included the following:

- DOE did not adequately address the issue of proliferation risk in the EIS.

- None of the alternatives were favorable to nonproliferation efforts and, thus, further evaluation should be conducted of innovative immobilization technologies (see "Other Processing Options Not in Draft EIS" above).

Several commentors expressed views concerning DOE's approach in seeking safeguards termination limit variances. These included:

- DOE's approach to seek a variance to safeguards termination limits is acceptable for those materials whose evaluations concluded that the materials presented minimal risk of proliferation.

- Variances to the safeguards termination limits present an invitation to terrorists and, as such, the granting of variances is opposed.

- The EIS should include more discussion on the variances, including the rationale for variances and a clear path for materials that do or do not receive variances.

- State technical agencies should be involved in DOE's variance decisions.

- DOE should delay the EIS until variance decisions were made for all of the categories and subcategories.

In response to these comments, DOE agrees that nonproliferation goals should be an important factor in deciding the processing technology for each of the Rocky Flats plutonium residues and scrub alloy. Nuclear nonproliferation considerations, including long-term proliferation risks, are discussed in Section 4.1.9 of this EIS. None of the actions evaluated in this EIS, including those that involve plutonium separation, would result in a substantial increase in proliferation risk.

In addition, the discussion of variances to safeguards termination limits has been expanded in the Final EIS. The process to obtain a variance is described in detail in Section 1.2.1 of the Final EIS. Section 1.2 of the Final EIS discusses conditions under which a variance to safeguards termination limits may be applied. Section 1.3.1 of the Final EIS identifies materials that have received a variance and introduces Alternative 4, Combination of Processing Technologies, to address materials for which a variance has been granted. DOE has also responded individually to each comment related to proliferation risks in Section 9.5 of the Final EIS.

❒ **Comments Related to Transportation—**A number of commentors addressed transportation. Many of these commentors were strongly opposed to any transportation of plutonium-bearing materials and suggested that the materials remain at Rocky Flats. Primary reasons and suggestions were:

- Transportation of materials poses the potential for accidents and resulting exposures to the public and contamination.

- Rocky Flats has the ability to stabilize or process the materials and, as such, transporting the materials is unnecessary.

- DOE should not transport materials through major metropolitan areas, such as Atlanta and Augusta.

Other comments on transportation included the following:

- Transportation can be accomplished safely (citing DOE's safe transportation record).

- DOE should better communicate with the public on the safety of DOE's shipments.

- The public should have input to routing decisions.

- DOE should not transport materials in Type B shipping containers that have not been certified by the U.S. Nuclear Regulatory Commission.

In response to these comments, DOE notes that the amount of transportation that would occur is dependent on the processing technology that would be selected in the Record of Decision for each plutonium residue and scrub alloy. Under the Preferred Alternative described in Section 2.5.2 of the Final EIS, most of the materials considered in this EIS would be repackaged (with stabliziation as necessary) at Rocky Flats, with minimal shipments to Los Alamos National Laboratory and the Savannah River Site for offsite processing (3 and 39 shipments, respectively). Section 2.8 of the Final EIS discusses the transportation system, including the Type B packaging used to transport these materials for any offsite processing. Appendix E, Section E.6, of this Final EIS shows that the incident-free radiological risk to the public in the form of latent cancer fatalities from transportation would be

less than one fatality. The accident risk to the public, including latent cancer and traffic fatalities, would also be less than one. DOE has also responded individually to each comment related to transportation in Section 9.5 of the Final EIS.

❒ **Comments Related to Environmental, Safety, and Health Risks—**About half of the comments addressed issues dealing with environment, safety, and health. These included comments on DOE's risk analysis methodology to determine impacts and concerns about risks posed by the alternatives.

Some commentors stated that the EIS analyses were adequate in addressing the impacts.

Others believed they were not adequate. Those comments dealing with inadequacies included the following:

- DOE underestimated worker exposures in the analyses (comments included both Rocky Flats and Savannah River Site processes). For example, DOE underestimated the condition of facilities at Rocky Flats (old and unsafe) and did not consider recent accidental exposures at the Savannah River Site.
- DOE should not compare voluntary activities (e.g., cigarette smoking) with involuntary activities.
- DOE underestimated waste volumes to be generated during processes.
- DOE underestimated water usage at Los Alamos National Laboratory.
- DOE needs to address RCRA permit modifications dealing with mixed waste in the EIS.
- WIPP documentation needs to address criticality due to some of the residue packages to be sent to WIPP.
- Transportation accidents pose unacceptable risks.

Some commentors (federal and state agencies) noted no impacts from the proposed actions in this EIS, including no impacts to endangered or potentially endangered species and critical habitats. Some commentors offered comments on environmental justice or equity issues.

In response to these comments, DOE has made refinements to the impact analyses in Chapter 4 of the Final EIS. Some of the changes occurred because DOE re-evaluated many of the processing technologies and introduced some new processing technologies. DOE believes that the processing methods analyzed in this EIS would be safe, based on the small potential impacts (less than one latent cancer fatality), as described in Sections 4.21, 4.22, and 4.23 of the Final EIS. DOE has also responded individually to each comment related to environmental, health and safety risks in Section 9.5 of the Final EIS.

❒ **Comments Related to Costs—**A few commentors included cost as a factor in their support or opposition of a technical alternative. These comments included the following:

- DOE should minimize costs devoted to duplicate processing facilities.
- The preferred alternative in the Draft EIS is not the least costly alternative.

- The plutonium separation processes will be more costly - DOE underestimated the costs of operating the canyons.

- Using Rocky Flats facilities for processing (no shipments offsite to more capable facilities) will be more costly.

- Rocky Flats should be prepared to cover costs of extending the life of the canyons if required to complete processing of Rocky Flats' materials.

- DOE must provide the necessary funding to implement the alternatives.

- Money devoted to plutonium separation should be redirected to pursuit of innovative immobilization technologies.

In response to these comments, DOE has provided a comparison of the costs of processing technologies in Section 4.17 of this Final EIS. Cost estimates range from $428 million for the Minimize Cost Approach to $1,129 million for the No Action Alternative. The Preferred Alternative has an estimated cost of $524 million. DOE has also responded individually to each comment related to costs in Section 9.5 of the Final EIS.

❒ **Other Comments - Miscellaneous—**DOE should define the ultimate decisionmaker for processing under this EIS.

- DOE should specify which site has ownership of the processed residues that will be shipped to WIPP.

- DOE has issued this EIS prematurely - more information on other innovative processing technologies, contingencies, and nonproliferation impacts is needed.

- DOE waited too long to address steps needed to remove the residues from Rocky Flats; expeditious DOE decisionmaking is vital to cleanup of Rocky Flats.

- More information is needed on selection criteria; the processing technologies in the preferred alternative are not consistent with selection criteria.

- The EIS was well-written and adequately addresses impacts.

- DOE should make the EIS available electronically.

DOE has responded individually to each miscellaneous comment in Section 9.5 of the Final EIS.

9.4.2 Environmental Protection Agency Rating of EIS

The U.S. Environmental Protection Agency, Region VIII, reviewed and rated the Draft EIS in its "Category EC–2," which indicates that "EPA has identified potential environmental impacts and the EIS does not contain sufficient information to fully assess these impacts." This rating was based on EPA's comment that there is no assurance that WIPP will be open any time in the near future or if it will ever be open to accept waste. Thus, EPA is concerned that the alternatives analyzed in the Draft EIS did not specifically analyze interim storage of the processed residues pending disposal or other disposition, e.g., onsite storage. EPA commented

that the EIS needs to have a back-up plan to safely secure and store all waste on site, including the evaluation of the use of existing buildings (upgrading) or the building of an additional structure.

DOE has addressed this comment by revising the alternatives and adding additional analyses for contingency storage in Section 4.14 of the Final EIS.

9.4.3 Summary of Public Hearings and Comments Received

Public comment hearings on the Draft EIS were held at the following locations during the public comment period:

- Rocky Flats Environmental Technology Site, Golden, Colorado, December 10, 1997
- Los Alamos Area Office, Los Alamos, New Mexico, December 11, 1997
- Savannah River Site area, Augusta, Georgia, December 16, 1997

The hearings were announced in the Federal Register Notice on the availability of the Draft EIS, as well as in local newspapers. The public comment hearings were informal in nature in order to allow for a free-flowing dialogue. The hearing attendees were offered an opportunity to provide formal remarks, which some opted to do. However, for the most part, attendees were able to ask questions, provide comments, and engage in open discussion. Attendees also had an opportunity to have one-on-one discussions with DOE representatives prior to and after the hearing sessions. A fact sheet and corresponding poster exhibits were made available at the hearings. The fact sheet is included in Appendix A of the Final EIS.

About 50 people attended the three public hearings. Attendees included local citizens, site employees, State and local officials, and representatives of various environmental or citizens organizations. About 40 comments and questions were received at the hearings. Key comments focused on the following concerns:

- More clarification on safeguards termination limits and variances to those limits, including conditions under which a variance would be granted, processing technologies that would be used for materials that have received or not received a variance, percentages of plutonium covered by existing variances, and status of variances.

- Questions or comments about specific processing technologies, such as salt distillation, salt scrub, water leach, Purex, and cementation.

- Suggestions to further evaluate vitrification options and use mobile vitrification units.

- Clarification on the final forms of the processed residues and separated plutonium.

- Clarification of the disposition path for separated plutonium.

- Clarification on the forms of the residues to be processed.

- Comments and clarification on the "pipe and go" concept (which is encompassed under the repackaging option in Alternative 4), including analyses that have been performed to address criticality.

- Suggestions to consider contingency storage at Rocky Flats.

- Suggestions to minimize transportation.

- Suggestions to consider other locations for smaller scale processing.

- Suggestions and questions on particular impacts analyses, including waste generated, emissions, process safety in terms of accidents, and transportation.

- Clarifications of materials that would be shipped to WIPP.

- Concerns about the Resource Conservation and Recovery Act designations for some residue categories, WIPP not receiving a State of New Mexico permit for receiving mixed wastes, and Colorado's jurisdiction over proposed disposition of RCRA wastes.

In response to these oral comments, DOE has provided additional clarifications in the applicable sections of Chapter 2 of the Final EIS, as well as in the DOE responses provided in Section 9.5.1 below. (See also above summary of written comments and DOE responses.)

9.5 DOE RESPONSES TO PUBLIC COMMENTS

Individual responses to each of the comments submitted to DOE, including all of those summarized above, are provided in the sections below.

9.5.1 Oral Comments at Public Hearings and DOE Responses

9.5.1.1 Rocky Flats Public Hearing

The public hearing at Golden, Colorado was held at the Rocky Flats Environmental Technology Site at Building 060 on December 10, 1997. Twenty people attended the meeting. The meeting discussion was interactive in nature. A summary of the key comments and issues that were raised and the DOE responses follow.

Summary of Issues Raised at Rocky Flats Public Hearing and DOE Responses		
Key Issues Raised		*DOE Responses*
1	DOE should define Safeguard Termination Limits (STL) and clarify how Rocky Flats would obtain variances from the STL requirements.	See response to Written Comment 28-5.
2	Sand, Slag, and Crucible (SS&C) material is stated to have low technical uncertainty on pg. 4-106 of Volume 1 of the Draft EIS. However, Appendix C, page C-41, states that processing risks are minimal, with the exception of SS&C. Please address this apparent difference.	Table 4-56, Technical Uncertainties for Processing Options, p. 4-106 of Volume 1 of the Draft EIS, correctly states that there is low technical uncertainty associated with the Purex processing option for ash residues at the Savannah River Site. Therefore, the citation specified in Appendix C, page C-41, has been corrected appropriately.
3	More attention should be given to furthering the development of vitrification technology to allow for other vitrification approaches at Rocky Flats.	See responses to Written Comments 31-8 and 31-9.
4	There should be greater research into a versatile mobile vitrification unit at Rocky Flats that could provide Rocky Flats with the capability to handle weapons-grade material stored at Rocky Flats. Vitrification with high-level waste at Rocky Flats should not be ruled out.	See response to Written Comment 8-7 regarding mobile vitrification units. The vitrification with high-level waste concept is not considered to be a viable alternative since the concept would require shipping high-level waste to Rocky Flats, where none now exists, constructing a vitrification facility at Rocky Flats, and qualifying the waste form for disposal. As described in Section 2.9.3 of this EIS, DOE does not consider constructing a new vitrification facility at Rocky Flats to be economically or technically viable, give the relatively small amounts of material requiring vitrification at the site.

Summary of Issues Raised at Rocky Flats Public Hearing and DOE Responses		
Key Issues Raised		***DOE Responses***
5	Offsite transportation of materials for further processing should be minimized.	See response to Written Comment 35-4.
6	DOE should consider smaller scale processing activities in several locations, rather than processing at only Los Alamos National Laboratory, the Savannah River Site, or Rocky Flats.	See response to Written Comment 17-3, second and third paragraphs.
7	DOE should assess waste produced by each option. All the different input/outputs, such as the hazardous chemicals in the waste streams and those used in the processes, should be specified in the EIS.	The EIS does specify the types of wastes produced by each processing alternative and any hazardous chemicals that would be used. Wastes associated with processing are given for each residue type and scrub alloy in Sections 4.2 through 4.11 of the EIS. Hazardous chemicals released to the atmosphere are addressed in these same sections and also in Section 4.12. A detailed process description for each process considered in the EIS is provided in Appendix C.
8	Cementation is not considered to be a good option; pondcrete is cited as an example of a failed project.	The EIS evaluates cementation as an alternative for all ash residues to stabilize these materials. The impacts that would result from use of this alternative are specified in Section 4.2 of the EIS. There are no alternatives considered in the EIS that resemble the “pondcrete” project. In the pondcrete project, settling basin materials from the solar evaporating pond were mixed with cement and water to form concrete that ultimately crumbled. In the cementation alternative analyzed in the EIS, the ash residue material is a more uniform material than that used in the pondcrete project. When blended with cement, the ash residues would result in better quality concrete.
9	Pollution liabilities and possible process safety issues in terms of accidents should be presented in the EIS.	Pollution issues and possible process safety issues in terms of accidents are presented in the EIS. Assessments are presented in terms of types of wastes generated and potential accident impacts for each processing technology evaluated. Sections 4.2 to 4.11 of Chapter 4 of the EIS describe all wastes generated during processing and estimate air emissions for hazardous chemicals, non-radiological air pollutants, and radiological materials. Accidents analyzed in the EIS are presented in Chapter 4 and Appendix D.

9.5.1.2 Los Alamos National Laboratory Public Hearing

The public hearing at Los Alamos, New Mexico, was held at the Los Alamos Area Office, on December 11, 1997. Seven people attended the meeting. The meeting discussion was interactive in nature. A summary of the key comments and issues that were raised and the DOE responses follow.

Summary of Issues Raised at Los Alamos Public Hearing and DOE Responses		
	Key Issues Raised	***DOE Responses***
1	Clarify the status of the Office of Nonproliferation and National Security's approval of Rocky Flats safeguard termination limit variances for certain materials. (A commentor asserted that approvals for combustible and direct repack residues were put on hold. The commentor also stated that correspondence from DOE/NN-51 was in process that would direct Rocky Flats not to implement safeguard termination limits variances until a vulnerability assessment is completed whereby Rocky Flats must demonstrate that the material will be safeguarded outside the protected area.)	See response to Written Comment 17-5.
2	Were the impacts from transporting waste from processing at Los Alamos to WIPP assessed?	The environmental impacts of shipping transuranic wastes to WIPP and the impacts of disposal at WIPP were analyzed in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS-II) described in Section 1.5.4 of this EIS. DOE has summarized these impacts and incorporated them by reference in Appendix E, Section E.6, of the Final EIS.
3	Why are there no emissions from salt processes?	The technology descriptions for the processes used at Los Alamos National Laboratory reported low levels of radioactive emissions from the processes but no hazardous chemical emissions. The radioactive doses to the offsite public for these processes are listed in Table 4-12 of the EIS. No hazardous chemicals are present in the residues and none are added during processing.
4	Is there a range of plutonium isotopes or just one isotope?	The isotopes are those contained in weapons-grade plutonium at Rocky Flats. These include: Plutonium-238, -239, -240, -241,-242, and Americium-241. These isotopes are referenced in Appendix D, Table D-22 and Table D-80, of the EIS.
5	Is there any mixed waste to be processed at Los Alamos?	See response to Written Comment 24-4.

Summary of Issues Raised at Los Alamos Public Hearing and DOE Responses		
	Key Issues Raised	***DOE Responses***
6	How much residue material would come to Los Alamos National Laboratory from Rocky Flats for processing under the preferred alternative? Specifically, how much plutonium and how much americium?	See responses to Written Comments 11-1 and 11-10.
7	How much material could go to WIPP?	See response to Written Comment 28-2.
8	Under the water leach processing option, would the material or residue leftover from extraction be considered low-level waste or transuranic waste?	The residual calcium chloride salt would be transuranic or low-level waste depending on the residual plutonium content. In this EIS, we assume it is all transuranic waste.
9	What is the plutonium concentration in the salts.?	The average plutonium concentration in the pyrochemical salt residues is approximately 6.7 percent; however, this plutonium concentration varies widely from one container to another. Full descriptions of the salts and other residues are addressed in Appendix C of this EIS.
10	The EIS appears to focus on direct disposal of all materials at WIPP without giving full consideration to the alternatives. Plutonium removal from certain materials seems to be more appropriate than putting more plutonium material in WIPP. If plutonium is recovered, the volume of waste will be vastly reduced. This point should be presented as the main focus of the EIS analyses.	As described in Section 1.2 of this EIS, the purpose and need for agency action is to process certain plutonium residues and scrub alloy currently in storage at Rocky Flats to address health and safety concerns raised by the Defense Nuclear Facilities Safety Board Recommendation 94-1, and to prepare them for offsite disposal or other disposition, while supporting site closure and limiting worker exposure and waste production. Section 2.5.2 of the Final EIS identifies the preferred alternative, which is comprised of preferred processing technologies for each material category (and some sub-categories). The detailed rationale for selecting the preferred technologies is provided in Section 2.4. With the exception of the No Action alternative, the management approach, "Process with Maximum Plutonium Separation," described in Section 4.22, does produce the minimum number of transuranic waste drums (based on the total of stabilized residue and transuranic waste which would both be sent to WIPP), as shown in Table 4-79, but also results in the highest number of canisters of high-level waste. Different processing technologies will have a different mix of high-level waste, transuranic waste, low-level waste, and low-level mixed waste.

Summary of Issues Raised at Los Alamos Public Hearing and DOE Responses		
	Key Issues Raised	***DOE Responses***
11	The EIS should clearly point out that plutonium is a valuable resource. Under the preferred alternative, plutonium disposed of at WIPP would be wasting several million dollars of electrical power resource (if the plutonium were recovered and converted to mixed oxides).	See response to Written Comment 17-7.
12	The EIS should clarify the approach for presenting data concerning the analysis of air quality pathways. Specifically, the rationale for why wind roses (for certain years) were used at some sites and an average was used for others should be provided.	See response to Written Comment 24-8.
13	Concern was expressed regarding the extent to which discarding residues at WIPP had been evaluated during the development of the WIPP SEIS-II. Greater public disclosure is needed as to the nature of these materials and the amount of plutonium content. Otherwise, WIPP could be prevented from opening when it is really needed for the disposal of transuranic wastes.	See response to Written Comment 16-1.
14	Concern was expressed that the bounding case numbers for WIPP may be exceeded. In particular, with decontamination and decommissioning and environmental restoration, Rocky Flats will exceed its allotment of WIPP drums (as cited in the *Baseline Environmental Management Report*).	See response to Written Comment 17-8.

Summary of Issues Raised at Los Alamos Public Hearing and DOE Responses		
	Key Issues Raised	***DOE Responses***
15	Some residue categories have RCRA designations and New Mexico has not certified DOE to send this material. Performance assessment assumed no reactive, corrosive codes; 15 Item Description Codes (IDCs) are prohibited in the WIPP/WAC. The treatment descriptions contained in the EIS should explicitly address the IDCs in question. Additionally, the Colorado Department of Public Health & Environment (CDPHE) has approval authority over the disposition of RCRA-regulated residues. Therefore, the CDPHE must be satisfied with any proposed disposition.	See response to Written Comment 17-4.
16	The EIS postulates that risks at Los Alamos and Rocky Flats are increased for plutonium separation. However, in the case of Los Alamos, it should be noted that plutonium separation is part of the facility's authorization basis. Rocky Flats has no authorization basis for nuclear operations.	See response to Written Comment 17-3.

9.5.1.3 Savannah River Site Public Hearing

The public hearing at Augusta, Georgia, was held at the downtown Ramada Plaza Hotel on December 16, 1997. Nineteen people attended the meeting. The meeting discussion was interactive in nature. A summary of the key comments and issues that were raised and the DOE responses follow.

Summary of Issues Raised at Augusta Public Hearing and DOE Responses		
Key Issues Raised		***DOE Responses***
1	Given DOE's goal to clean up and close Rocky Flats by 2006 [as specified in the *Rocky Flats Cleanup Agreement* between DOE, EPA, and the State of Colorado], it is uncertain whether Rocky Flats intends to do any processing of the residues.	The purpose and need for agency action is to process certain plutonium residues and the scrub alloy currently in storage at Rocky Flats to address health and safety concerns regarding storage of the materials and to prepare the materials for offsite disposal or other disposition. The processes identified in this EIS support Rocky Flats' ability to clean up and close the site by 2006. The alternatives analyzed for processing at Rocky Flats were selected based on Rocky Flats' ability to conduct those processes during the 1998-2004 timeframe. The action would be taken in a manner that supports site closure and limits worker exposure and waste production. DOE is committed to closing Rocky Flats by 2006, as described in DOE's "Accelerating Cleanup: Paths to Closure," described in Section 1.5.11 of this EIS.
2	Clarify how the EIS alternatives would be affected if additional variances are not granted (i.e., can Rocky Flats process those residues that do not receive a variance).	See responses to Comments 15-3 and 15-5.
3	Clarify how decisions can be made and implemented from this EIS when variance evaluations and technology studies are still ongoing?	Decisions to be made from this EIS will be based upon information available and the status of technology at the time of the Record of Decision. See also response to Comment 15-5.
4	Clarify the schedule for issuance of the Final EIS and Record of Decision.	See response to Comment 15-5.
5	Clarify the percentage of plutonium covered by the existing variances compared to the total amount of plutonium analyzed in the EIS.	Approximately 2,780 kilograms of plutonium are contained in all of the residues and scrub alloy analyzed in this EIS. A variance to safeguards termination limits has been granted to all of these materials, except the plutonium fluorides, Ful Flo filters and scrub alloy, which contain, collectively, approximately 362 kilograms of plutonium (142 kilograms in the fluorides, 19.6 kilograms in the Ful Flo filters, and 200 kilograms in the scrub alloy). This equates to about 2,418 kilograms of plutonium in materials for which a variance has been granted. Therefore, the percentage of plutonium covered by an existing variance represents about 87 percent of the total plutonium analyzed in the EIS. [Note: As a result of further characterization of the residues since the Draft EIS was issued, Rocky Flats concluded that many residues would only need to be repackaged prior to disposal at WIPP because much of the residue inventory would not require stabilization prior to repackaging to meet WIPP waste acceptance criteria. Rocky Flats requested and obtained a variance to safeguards termination limits that covers residues, including Ful Flo filters, with plutonium concentrations below 10 percent. However, Ful Flo filters were not identified in the Draft EIS as a material for which a variance to the safeguards termination limit had been requested, and accordingly, application of a variance was not considered for the Final EIS.]

Summary of Issues Raised at Augusta Public Hearing and DOE Responses		
Key Issues Raised		***DOE Responses***
6	The salt distillation process may not be workable at Los Alamos National Laboratory; salt scrub should be considered as the preferred alternative at Los Alamos National Laboratory.	Although salt distillation is no longer the preferred processing technology for salts, the analyses conducted as part of this EIS have indicated that salt distillation at Los Alamos National Laboratory is a feasible process for certain materials (molten salt extraction electrorefining salts). Water leach at Los Alamos National Laboratory or Rocky Flats is also identified as a reasonable processing technology. However, at the recommendation of Los Alamos National Laboratory, the Final EIS includes evaluation of an additional process, acid dissolution followed by plutonium oxide recovery, for processing direct oxide reduction salts (with high-concentration plutonium) at Los Alamos National Laboratory. This is a mature process and has been identified as the preferred alternative for processing these direct oxide reduction salt residues at Los Alamos National Laboratory. The reasons for adding the acid dissolution processing technology are explained in Section 2.4.2 of this EIS.
7	Clarify the disposition path for plutonium separated in the Savannah River Site canyons.	The disposition path for any plutonium separated under Alternative 3 of this EIS is discussed in Sections 1.2.2 and 2.7.2 of the Final EIS.
8	Clarify the final forms of the processed residues that will be shipped to the WIPP (including repackaged and immobilized materials).	The residues to be disposed of in WIPP would be repackaged, stabilized, or processed to conform to the WIPP waste acceptance criteria. The forms would vary depending on the material category or subcategory. Immobilized materials would be placed into glass, cement, or ceramic forms. Repackaged and stabilized residues would be in various forms, including cements, metals, clinkers of ash and firebrick, rubber, wood, and glass. (Refer to Appendix C for more details on the forms of the stabilized or processed wastes to be shipped to WIPP.)
9	Clarify DOE's consideration of the "pipe and go" alternative and whether sufficient analyses have been conducted on this approach.	The "pipe and go" concept is encompassed under Alternative 4. Alternative 4, described in Sections 1.3.1, 2.1, and 2.4, provides for direct repackaging of certain residues into a pipe component when characterization data indicates that the residue poses low risk. (In some cases, stabilization and blending would be required prior to repackaging.) The pipe component and the drum into which it is placed would be used to store most plutonium residues after processing or repackaging. The drum containing the pipe component would be placed inside a TRUPACT-II shipping container before transporting the residues to the WIPP. The pipe component is described in Section 2.6.1. The pipe component was originally developed to create a safe interim storage alternative (until WIPP is available) to the existing facilities/conditions. Subsequent analysis has shown that the robustness of this container (designed to prevent dispersal during a design seismic event) also eliminates the criticality risks of the residues, greatly improves the efficiency of TRUPACT-II transportation, decreases vulnerability of materials to terrorist attack during shipment, and potentially avoids the need to process materials for plutonium separation before disposal.

Summary of Issues Raised at Augusta Public Hearing and DOE Responses		
	Key Issues Raised	***DOE Responses***
10	Clarify whether DOE has analyzed criticality risks associated with an accident involving water submersion of the pipe component -- where water intrudes into the package, the salts dissolve, and the water transports the plutonium to another location where it could deposit in a critical configuration.	As the basis for developing the WIPP waste acceptance criteria, extensive accident analyses using computer modeling were performed for the maximum amount of plutonium that could be placed in 14 drums within a TRUPACT-II shipping container. The maximum amount was based upon 200 fissile gram equivalent per drum. This made the total amount of plutonium considered to be 2,800 fissile gram equivalent, which is the maximum amount allowed in a TRUPACT-II using pipe components. One of the modeling scenarios was total immersion of the TRUPACT-II in water, along with total immersion of the drums in water inside the TRUPACT-II, as well as simultaneously having all internal containers disappear (i.e., drums and pipe components) and all the plutonium being available to conglomerate in one corner of the TRUPACT-II. Even with this idealized scenario, the modeling showed no concerns regarding criticality of the plutonium.
11	Address whether the “pipe and go” packaging system referred to in comment 9, above, results in higher concentrations of plutonium in the package than considered in analyses performed for WIPP. If so, has DOE considered the potential for criticality when emplaced in WIPP?	The pipe-and-go concept (see response to Comment 9 above) would not result in higher concentrations of plutonium in the package than previously considered in criticality analyses performed for WIPP. The maximum amount of plutonium allowed in a pipe component to be placed inside a 55-gallon drum is 200 fissile gram equivalent. All of the analyses performed for WIPP have been based on a 200-fissile gram equivalent limit per drum, which has been the standard loading for transuranic waste drums for over 20 years. The use of the pipe component instead of only a drum would allow a greater amount of plutonium to be placed into a TRUPACT-II (2,800 fissile gram equivalent versus 325 fissile gram equivalent) for shipment to WIPP. However, the total amount of plutonium shipped from Rocky Flats using this “pipe-and-go” packaging system would not exceed the amount allocated for Rocky Flats shipments in WIPP’s criticality analyses. When account is taken of this and the limited amount of plutonium that could be placed inside a drum, the need to perform additional criticality calculations is precluded. The WIPP waste acceptance criteria established the conditions that govern the physical, radiological, and chemical composition which transuranic waste must meet before it can be accepted and emplaced at WIPP. Radiological criteria include the maximum plutonium-239 equivalent activity for stored transuranic waste to avoid the potential for nuclear criticality. Acceptable package limits are less than 200 fissile gram equivalent per drum. These limits are two times the measurement error when the waste packages are assayed. On average, a drum of Rocky Flats plutonium residue waste would contain 8.6 curies of plutonium-239 and 50.5 curies of plutonium-241 per drum, which represents approximately 139 fissile gram equivalent in a drum. The proposed processing under consideration in the Final EIS could further reduce the fissile gram equivalent concentrations in this waste.
12	DOE should consider developing a new storage facility at Rocky Flats to (1) resolve near-term problems of drums exposed to the elements (e.g., strong winds); and (2) provide for contingency in the event of scheduling delays with WIPP.	See response to Written Comment 23-2.

Summary of Issues Raised at Augusta Public Hearing and DOE Responses		
Key Issues Raised		**DOE Responses**
13	Clarify requirements for storage of separated plutonium (i.e., would storage be in accordance with DOE Standard 3013?).	Storage of separated plutonium resulting from processes analyzed in this EIS would be in accordance with DOE-STD-3013-96, *DOE Standard: Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage* (DOE 1994b). For a more detailed discussion, refer to Section 2.6.2.

9.5.2 Written Comments and DOE Responses

This section provides a side-by-side display of the written comments received (full-text reproductions) and DOE's responses. Individual comments are numbered in the margins of the comment letters, and DOE responses to each of the numbered comments are provided on the right side of each page. To aid the reader in locating particular comments, indexes are provided at the beginning by:

- Name and Affiliation
- Key Issue Areas.

INDEX OF WRITTEN SUBMISSIONS BY NAME AND AFFILIATION

1. Lois Pohl, Coordinator, Missouri Clearinghouse, State of Missouri, Office of Administration

2. Kenneth W. Holt, MSEH, Special Programs Group (F16), National Center for Environmental Health, Department of Health and Human Services, Centers for Disease Control and Prevention for Oceans and Atmosphere, Atlanta, Georgia

3. Susan B. Fruchter, Acting NEPA Coordinator, Office of the Undersecretary for Oceans and Atmosphere, U.S. Department of Commerce, Washington, D.C., forwarding comment by Charles W. Challstrom, Acting Director, National Geodetic Survey, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

4. Carl M. Edstrom, Arvada, Colorado

5. *Intentionally left blank.*

6. Craig C. Kocian, City Manager, City of Arvada, Colorado

7. Ronald A. Hellbusch, Director Public Works and Utilities, and Mary Harlow, Rocky Flats Coordinator, City of Westminster, Colorado

8. Deborah Reade, Citizens for Alternatives to Radioactive Dumping (CARD), Albuquerque, New Mexico

9. Tom C. Smith, Port Arkansas, Texas

10. Donald F. Dustin, Boulder, Colorado

11. Greg Mello, Director, Los Alamos Study Group, Santa Fe, New Mexico

12. Fred E. Humes, Director, Economic Development Partnership, Aiken, South Carolina

13. Joel T. Cassidy, Executive Director, South Carolina Employment Security Commission, Office of State Budget, South Carolina Project Notification and Review, Columbia, South Carolina (forwarded by Rodney P. Grizzle, Grants Services Coordinator, State Budget and Control Board, Office of State Budget, State of South Carolina)

14. Robert F. Stewart, Regional Environmental Officer, Office of Environmental Policy and Compliance, Office of the Secretary, U.S. Department of the Interior, Denver, Colorado

15. Joe Schieffelin, Permitting and Compliance Unit Leader, Federal Facilities Program, Hazardous Materials and Waste Management Division, Colorado Department of Public Health and Environment, Denver, Colorado

16. Dana C. Christensen, Los Alamos, New Mexico

17. Mark A. Robinson, Los Alamos, New Mexico

18. Danny Johnson, (for Robert E. Duncan, Environmental Programs Director), South Carolina Wildlife and Marine Resources Department, State of South Carolina (forwarded by Rodney P. Grizzle, Grants Services Coordinator, State Budget and Control Board, Office of State Budget, State of South Carolina)

19. Turner Styons, Deputy Executive Director, South Carolina State Housing Authority, State of South Carolina (forwarded by Rodney P. Grizzle, Grants Services Coordinator, State Budget and Control Board, State of South Carolina)

20. George Bistany, Grants Manager, South Carolina Department of Commerce, State of South Carolina (forwarded by Rodney P. Grizzle, Grants Services Coordinator, State Budget and Control Board, Office of State Budget, State of South Carolina)

21. Beth McClure, Director, RP&D, South Carolina Department of Parks, Recreation and Tourism, State of South Carolina (forwarded by Rodney P. Grizzle, Grants Services Coordinator, State Budget and Control Board, Office of State Budget, State of South Carolina)

22. Ronald E. Mitchum, Berkeley-Charleston-Dorchester Council of Governments, State of South Carolina (forwarded by Rodney P. Grizzle, Grants Services Coordinator, State Budget and Control Board, Office of State Budget, State of South Carolina)

23. Cynthia Cody, Chief, NEPA Unit, Office of Ecosystems Protection and Remediation, U.S. Environmental Protection Agency, Region VIII, Denver, Colorado

24. Gedi Cibas, Ph.D., Environmental Impact Review Coordinator, State of New Mexico Environment Department, Santa Fe, New Mexico

25. Tom Marshall, Chair, Rocky Flats Citizens Advisory Board, Westminster, Colorado

26. Victor Holm, Member, Rocky Flats Citizens Advisory Board

27. Brian Costner, Energy Research Foundation, South Carolina (on behalf of 13 organizations)
    Carolina Peace Resource Center, South Carolina
    Citizens for Environmental Justice, Georgia
    Concerned Citizens for Nuclear Safety, New Mexico
    Georgia Peace Action, Georgia
    GE Stockholders' Alliance for a Sustainable, Nuclear-Free Future, Arizona
    Global Resource Action Center for the Environment, New York
    Los Alamos Study Group, New Mexico
    Oak Ridge Environmental Peace Alliance, Tennessee
    Rocky Mountain Peace and Justice Center, Colorado
    Snake River Alliance, Idaho
    Southwest Research and Information Center, New Mexico
    STAND of Amarillo, Texas

28. Robert H. Neill, Director, Environmental Evaluation Group, Albuquerque, New Mexico

29. *Intentionally left blank.*

30. Ann Loadholt, Chairperson, Savannah River Site Citizens Advisory Board

31. Rocky Mountain Peace and Justice Center, Boulder, Colorado

32. Tom Marshall, Chair, Rocky Flats Citizens Advisory Board, Westminster, Colorado

33. Susan Gordon, Director, Alliance for Nuclear Accountability (ANA)

34. Candace M. Thomas, Chief, Environmental Analysis Branch, Planning Division, Corps of Engineers, Omaha District, Department of the Army, Omaha, Nebraska

35. Ralph Hutchison, Coordinator, Oak Ridge Environmental Peace Alliance, Oak Ridge, Tennessee

36. Diana Lobrano, Women's Action for New Directions, Atlanta, GA

37. Virginia Dollar, Co-Director, Alternatives In Action!

38. Adele Kushner, President, Action for a Clean Environment, Alto, GA

39. Donn Kesselheim, Lander, Wyoming

40. Emily B. Calhoun, Alto, GA

41. Nadean Young, Women's Action for New Directions (Rochester Chapter), Rochester, NY

INDEX OF WRITTEN COMMENTS BY KEY ISSUE AREA

A. COMMENTS DEALING WITH THE TECHNICAL ALTERNATIVES

(These include comments on the specific alternatives and sites that would implement the alternatives)

Alternative 1: No Action

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Alternative 2: Processing without Plutonium Separation

6-1, 7-2, 7-3, 7-4, 8-1, 9-1, 27-14, 31-7, 32-2, 33-6, 35-3, 36-2, 37-2, 38-2, 39-2, 41-2

Alternative 3: Processing with Plutonium Separation

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Other Processing Options (Not Included in Alternatives Identified in Draft EIS)
(These include comments on direct repackaging in a pipe container for shipment to WIPP; other immobilization technologies, such as cold ceramification and GMODS; and other site locations)

7-6, 8-7, 26-4, 27-14, 27-23, 31-1, 31-7, 31-8, 31-9, 32-6, 33-11

Specific to Rocky Flats

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Specific to Los Alamos National Laboratory

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B. COMMENTS DEALING WITH STORAGE

(These include comments on the need to address contingency storage at Rocky Flats in the event of delays in opening WIPP, interim storage at other processing sites, risks of continued storage at Rocky Flats, and storage of americium-contaminated materials.)

6-1, 6-2, 8-1, 8-7, 8-8, 10-3, 11-1, 11-10, 11-11, 11-12, 12-2, 17-2, 23-2, 24-3, 26-1, 26-3, 30-1, 31-1, 31-4, 31-5, 31-9, 31-11, 32-1, 32-2, 32-4, 33-5, 33-6, 36-2, 37-2, 38-2, 39-2, 41-2

C. COMMENTS DEALING WITH ULTIMATE DISPOSITION

(These include comments on the Waste Isolation Pilot Plant and disposition of separated plutonium under Alternative 3, which is being addressed by the Plutonium Disposition EIS)

6-1, 8-11, 9-3, 16-1, 17-2, 17-4, 17-7, 17-9, 23-2, 24-5, 27-1, 27-14, 28-3, 28-4, 28-5, 28-6, 28-7, 28-8, 28-11, 28-12, 28-14, 31-4, 31-5, 32-2, 33-6, 33-7

D. COMMENTS DEALING WITH PROLIFERATION RISKS

(These include comments about risks of terrorism or theft as a result of any of the technical alternatives or transportation, safeguards termination limits, and variances to the safeguards termination limits)

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E. COMMENTS DEALING WITH TRANSPORTATION

(These include comments about the transportation of the materials offsite for processing and to WIPP following stabilization, repackaging, or processing)

6-1, 8-3, 8-4, 8-5, 9-2, 9-3, 9-5, 10-2, 17-8, 24-1, 27-21, 27-22, 28-1, 28-2, 28-12, 30-1, 31-11, 33-8, 35-2, 35-4, 36-1, 36-2, 37-1, 37-2, 37-4, 38-1, 38-2, 39-1, 39-2, 40-1, 41-1, 41-2

F. COMMENTS DEALING WITH ENVIRONMENTAL, SAFETY, AND HEALTH RISKS

(These include comments about the health and safety risks to workers and the public from implementing the alternatives in this EIS or from transportation, amounts of waste/materials generated, emissions, RCRA, ecological impacts, environmental justice, and DOE's methodologies for analyzing and presenting risks)

2-2, 3-1, 6-1, 7-2, 7-5, 8-1, 8-3, 8-5, 8-10, 8-12, 8-13, 10-1, 10-2, 11-3, 11-4, 11-5, 11-6, 11-7, 11-8, 11-9, 11-11, 14-1, 14-2, 17-2, 17-3, 17-4, 17-6, 17-8, 17-9, 24-4, 24-7, 24-8, 26-3, 27-7, 27-8, 27-9, 27-10, 27-11, 27-12, 27-13, 27-15, 27-20, 27-22, 28-3, 28-7, 28-10, 28-11, 28-14, 30-1, 32-3, 33-5, 33-8, 33-9, 34-1, 36-1, 36-3, 37-1, 37-3, 38-1, 38-3, 39-1, 39-3, 41-1, 41-3

G. COMMENTS DEALING WITH COSTS

(These include comments about increasing or decreasing costs due to implementing any of the alternatives and funding availability)

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H. OTHER

(These include other comments not captured in the above categories, such as general comments on the adequacy of the EIS, DOE's decision process, equity, public involvement process, EIS availability, and editorial comments)

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Penasco, Pueblo of Picuris
San Felipe, Pueblo San Felipe
San Juan Pueblo, Eight Northern Indian Pueblos Council
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Sante Fe, Pueblo of Nambe
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Zimmerman, Representative Paul

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GA Department of Natural Resources, Program Manager
GA Department of Natural Resources, Setser, James
GA Geologic Survey
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GA House of Representatives, Deloach, the Honorable George
GA House of Representatives, Harbin, the Honorable Ben L.
GA House of Representatives, Howard, the Honorable Henry L.
GA House of Representatives, Williams, the Honorable Robin L.
GA Public Service Comm., Bugg, Bruce, Captain
GA Senate, Cheeks, the Honorable Donald E.
GA Senate, Committee on Natural Resources, Gillis Sr., the Honorable Hugh M.
GA Senate, Johnson, the Honorable Eric
GA Senate, Walker, the Honorable Charles
GA State Clearinghouse/Office of Planning and Budget, Reid, Tripp, Administrator
Lieutenant Governor, Howard, the Honorable Pierre

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Merritt, Allan

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Kansas Department of Health & Environment, Cooper, Vick
Kansas Department of Health & Environment, Hammer-Schmidt, Ronald
Kansas State Legislature, Freeborn, Joann

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Missouri Department of Natural Resources, Teeter, Ken

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State of New Mexico Environment Department, Weidler, Mark E.
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Office of Exec Policy & Programs, Carter, Fred
Office of the Governor, Thompson, Eric
Office of the Governor, Tompkins, Warren, Chief of Staff
Office of the Governor, Zimmerman, Robyn, Press Secretary
Office of State Budget/SC Project Notification & Review, Duncan, Robert E.
SC Department of Agriculture, Assistant Commissioner
SC Department of Archives & History, Hill, Ian D.
SC Department of Archives & History, Vogt, George
SC Department of Commerce, Bistany, George, Grants Manager
SC Department of Commerce, Burgess, Ed
SC Department of Health & Environmental Control, Allen, P. Brent
SC Department of Health & Environmental Control, Autry, Virgil
SC Department of Health & Environmental Control, Batavia, M. K.
SC Department of Health & Environmental Control, Berry, Russell
SC Department of Health & Environmental Control, Chief
SC Department of Health & Environmental Control, Coffey, Alan
SC Department of Health & Environmental Control, Collinsworth, Keith A.
SC Department of Health & Environmental Control, Commissioner
SC Department of Health & Environmental Control, Cribb, Sharon
SC Department of Health & Environmental Control, Hanson, Danny W.
SC Department of Health & Environmental Control, Kinney, Ronald
SC Department of Health & Environmental Control, Mathis, Harry
SC Department of Health & Environmental Control, Ragan, Francis Ann
SC Department of Health & Environmental Control, Reece, Myra
SC Department of Health & Environmental Control, Shaw, Lewis
SC Department of Health & Environmental Control, Taylor, G. Kendall

SC Department of Health & Environmental Control, Wilson Jr., David E.
SC Department of Highways & Public Transportation, Dubose III, W. M.
SC Department of Highways & Public Transportation, McIlwain, William L.
SC Department of Natural Resources, Environmental Coordinator
SC Department of Parks, Recreation & Tourism, McClure, Beth
SC House of Representatives, Cave, the Honorable Wilbur L.
SC House of Representatives, Mason, the Honorable Rudy M.
SC House of Representatives, Sharpe, the Honorable Charles R.
SC Geological Survey, Boozer, Alton C.
SC Geological Survey, State Geologist
SC Joint Legislative Committee on Energy, Manncromer Jr., the Honorable James L.
SC Joint Legislative Committee on Energy, Moore, the Honorable Thomas L.
SC Joint Legislative Committee on Energy, Research Director
SC Joint Legislative Committee on Energy, Scott, the Honorable John L.
SC Senate, Cork, the Honorable Holly A.
SC Senate, Leventis, the Honorable Phil P., Chairman
SC Senate, Peeler Jr., the Honorable Harvey S.
SC State Development Board, Director
SC State Housing Authority, Styons, Turner, Deputy Executive Director
SC Wildlife & Marine Resources Department, Timmerman Jr., James A., Director
State of SC, Condon, the Honorable Charles, Attorney General
State of SC, McKay III, Douglas, Senior Executive Asstistant for Economic Development
SC State Water Resources Commission, Deputy Director

Tennessee

TN Department of Environment & Conservation, Leming, Earl
TN Department of Environment & Conservation, Mobley, Michael
TN Department of Environment & Conservation, Shults, Debra
TN Department of Environment & Conservation, Wilson, Justin

Mayors

Aiken, SC, Cavanaugh Jr., the Honorable Fred B.
Augusta, GA, Sconyers, the Honorable Larry
Denver, CO, Webb, the Honorable Wellington E.
East St. Louis, IL, Bush, the Honorable Gordon
Golden, CO, Schenck, the Honorable Jan C.
Kansas City, MO, Cleaver II, the Honorable Emanuel
Nashville, TN, Bredesen, the Honorable Philip
North Augusta, SC, Jones, the Honorable Lark
Paducah, KY, Jones, the Honorable Albert
Pueblo, CO, Garcia, the Honorable Cathy
Salina, KS, Seaton, the Honorable Kristin
Santa Fe, NM, Jaramillo, the Honorable Debbie
Savannah, GA, Adams Jr., the Honorable Floyd
Springfield, IL, Hasara, the Honorable Karen
St. Louis, MO, Harmon, the Honorable Clarence
Topeka, KS, Wagnon, the Honorable Joan

Federal Organizations

Defense Nuclear Facilities Safety Board
Federal Emergency Management Agency
Office of Management and Budget
U.S. Army Corps of Engineers
U.S. Department of Commerce
U.S. Department of Commerce, National Oceanic and Atmospheric Administration
U.S. Department of Defense
U.S. Department of Health and Human Services, Centers for Disease Control
U.S. Department of the Interior
U.S. Department of the Interior, U.S. Fish & Wildlife Service
U.S. Department of State
U.S. Department of Transportation
U.S. Environmental Protection Agency
U.S. Environmental Protection Agency Region 4
U.S. Environmental Protection Agency Region 6
U.S. Environmental Protection Agency Region 7
U.S. Environmental Protection Agency Region 8
U.S. Environmental Protection Agency Region 9
U.S. Nuclear Regulatory Commission

Local Government

California

City of Berkeley, Al-Hadithy, Nabl
City of Berkley, Belcher, Steve
City of Berkeley, Marshall, Shirley
City of Berkeley, Schafer-Bright, Tamlyn
Environmental Health Services, Miller, Rick
SWRCB, Torres, Gilbert
Ventura County Board of Supervisors

Colorado

Adams County, Deherrea, Commissioner Guillermo
Adams County, Flaun, Commissioner Martin
Adams County, Valente, Commissioner Elaine
Boulder County, Mendez, Jana
Boulder County, Page, Commissioner Homer
Boulder County, Stewart, Commissioner Ron
City of Arvada, Kocian, Craig C., City Manager
City of Arvada, Roby, Bob, City Manager
City of Boulder, Honey, Tim, City Manager
City of Broomfield, DiCiero, George, City Manager
City of Denver, Environmental Services, Demos, E. K., Director
City of Erie, Wurl, Leon, Manager
City of Golden, Bestor, Mike, City Manager
City of Lafayette, Hornbacker, Mary Ellen, City Manager
City of Lakewood, Rock, Michael J.
City of Longmont, Pedrow, Gordon, City Manager
City of Louisville, Simmons, William, City Manager
City of Northglenn, Landeck, Jim, City Manager

City of Superior, Combo, Karen, City Manager
City of Thornton, Ethredge, Jack, City Manager
City of Westminster, Christopher, Bill, City Manager
City of Westminster, Harlow, Mary, Rocky Flats Coordinator
City of Westminster, Hellbusch, Ronald A., Director
City of Wheat Ridge, Middaugh, Robert, City Manager
Denver City Council, Ortega, Deborah, City Councilwoman
Environmental Health Service, Theophilos, George, Director
Jefferson County, Laura, Gary
Jefferson County, Miller, Betty
Jefferson County, Stone, John, Commissioner
Jefferson Economic Council, Dunshee, Don, President
Jefferson Economic Council/RFLII, Gilmore, Rob, Vice President
Public Information Specialist, True, Bob

Georgia

Augusta Richmond County, Todd, Moses
Chatham County Commission, Chariman
Industrial & Domestic Water Supply Comm., Director
Judicial Bldg., Bowers, the Honorable Michael, Attorney General
Metropolitan Planning, Rutherford, Dave
Planning & Development Commission, Director, Central Savannah River Area

Missouri

City of Kansas City Environmental Management, Sherritz, Peter, Environmental Generalist
City of Kansas City Planning and Development, Gustafson, Don, Transportation Planner

New Mexico

Bandelier National Monument, Weaver, Roy, Superintendent
Community Development Department, Fenner, Kevin
Community Development Department, Schlosser, Judith
Incorporated County of Los Alamos, Bagley, Roger
Incorporated County of Los Alamos, Georgieff, Alex, Administrator
Rio Arriba County, Valdez, Lorenzo, Manager

South Carolina

Aiken SC Department of Public Safety, Taylor, Gerald, Captain
Aiken County Public Schools, Eldridge, Linda B., Superintendent
Aiken County Public Schools, Green, James, Asst. Superintendent for Admin. Area 4
Allendale City Council, Chairman
Allendale County, Administrator
Barnwell County Council, Gripp, W. A., Administrator
Beaufort County, Administrator
Beaufort-Jasper Water and Sewer Authority, Chairman of the Board
Beaufort-Jasper Water and Sewer Authority, Moss Jr., William Dean, General Manager
Low Country Council of Governments, Director
Reinhart, Peggy
SC Coastal Council, Smith, Jack, Staff Attorney
Water Resources Comm. State of SC, Legal Counsel

Hazmat/Fire/Police

California

Camarillo, County of Ventura Fire Protection/HMS
Sacramento, Department of Toxic Substances Control - Hazardous Waste Management Program

Colorado

Denver, Colorado State Patrol
Flagler, Flagler Fire Department

Georgia

Atlanta, Atlanta Fire Department
Atlanta, Atlanta-Fulton County Emergency Management Agency
Atlanta, Georgia Emergency Management Agency

Illinois

Belleville, St. Clair County Sheriff's Department
Carlyle, Clinton County Emergency Management Agency
Marion, Williamson County Emergency Management Agency
Mt. Vernon, Jefferson County Sheriff's Department
Mt. Vernon, Mt. Vernon City Fire Department
Nashville, Washington County Sheriff
Springfield, Illinois State Police
Vienna, Johnson County Emergency Management Agency
West Frankfort, Franklin County Emergency Services Division

Kansas

Colby, Colby Fire Department
Goodland, Sherman Co. Sheriff's Department
Hays, Ellis County Emergency Management Agency
Hays, Hays Fire and Inspection Services
Kansas City, Wyondotte County Emergency Management Agency
Lincoln, Russell County Emergency Management Agency
Olathe, Johnson County Emergency Management Agency
Russell, City of Russell Kansas, Fire Chief
Topeka, Shawnee County Emergency Management Agency
Topeka, Kansas Division of Emergency Management Agency
Topeka, Kansas Highway Patrol

Kentucky

Benton, Marshall County Emergency Management Agency
Cadiz, Trigg County Emergency Management Agency
Hopkinsville, Christian County Emergency Management Agency
Hopkinsville, City of Hopkinsville, Fire Chief
Hopkinsville, Hopkinsville Fire Department
Paducah, Paducah-McCracken Co. Emergency Services

Missouri

Boonville, Cooper County, Sheriff
Corder, Lafayette County Emergency Management Agency

Fulton, Calloway County Emergency Management Agency
Jefferson City, Missouri State Highway Patrol
Kansas City, Hazmat Fire Station
Kansas City, Kansas City Fire Department
St. Louis, Ellis County Emergency Management Agency
St. Louis, St. Louis Emergency Management Agency
St. Louis, St. Louis Emergency Services
St. Louis, St. Louis Fire Department
Warrenton, Warren County Sheriff's Department

South Carolina

Aiken, Aiken County Emergency Services

Tennessee

Ashland City, Cheatham County Emergency Management Agency
Chattanooga, Hamilton County Sheriff's Department
Clarksville, Montgomery County Emergency Management Agency
Jasper, Marion County Emergency Management Agency
Manchester, Coffee County Emergency Management Agency
Nashville, Commercial Vehicle Enforcement
Nashville, Davidson County Emergency Management Agency
Nashville, Nashville Fire Department
Nashville, Tennessee Emergency Management Agency
Smyna, Nissan Motor Mfg. Corporation U.S.A.

Organizations

California

Menlo Park, Stanford Management Co.
Monterey, CRWQCB
Oakland, RWQCB
Palo Alto, Coordinated Resource Management
Sacramento, Dames & Moore
Sacramento, RWQCB
Sacramento, SWRCB
San Diego, General Atomics
Woodland Hills, LACRO

Colorado

Arvada, Athena's Consulting Network, Inc.
Denver, Colorado Association of Commerce and Industry
Denver, Spencely and Associates
Golden, Jefferson County Associates
Golden, Science Applications International Corporation
Golden, United Steelworkers Local 8031
Lakewood, RAC Development Corporation
Westminster, Church Ranch
Westminister, United Steelworkers

District of Columbia

BNFL, Inc.
Urban Energy & Transportation Corporation

Georgia

Athens, Exploration Resources
Atlanta, Georgia Power Company

Illinois

Lombard, Council of State Governments

Missouri

Kansas City, Urban Energy & Transportation Corporation

New Mexico
Albuquerque, Tetra Tech, Inc.
Carlsbad, Westinghouse Electric Corporation
Peñasco, La Communidad

South Carolina
Aiken, Quality Partners
Beaufort, Coastnet

Tennessee
Oak Ridge, ORISE

Chambers of Commerce

Colorado
Arvada, NW Metro Chamber of Commerce
Boulder, Boulder Chamber of Commerce
Broomfield, Broomfield Chamber of Commerce
Denver, Denver Metro Chamber of Commerce
Denver, Metro North Chamber of Commerce
Evergreen, Evergreen Chamber of Commerce
Golden, Greater Golden Chamber of Commerce
Lafayette, Lafayette Chamber of Commerce
Lakewood, West Chamber-Jefferson County
Longmont, Longmont Chamber of Commerce
Louisville, Louisville Chamber of Commerce

Georgia
North Augusta, Greater N. Augusta Chamber of Commerce

Public Interest Groups

Arizona
Phoenix, Sierra Club, Southwest Office

California
Clarksburg, Friends of the World
Livermore, Tri-Valley Cares
Los Angeles, Natural Resources Defense Council
Oakland, UC General Counsel
Oakland, Western States Legal Foundation
Palo Alto, Friends of the Creek

Colorado
Arvada, Rocky Flats Local Impacts Initiative
Boulder, Boulder Green Alliance
Boulder, Colorado Peace Action
Boulder, Environmental Defense Fund, Rocky Mountain Regional Office
Boulder, Land and Water Fund of the Rockies
Boulder, National Audubon Society

Boulder, Rocky Mountain Peace and Justice Center
Boulder, Solstice Institute
Boulder, The Nature Conservancy
Boulder, University of Colorado, Environmental Center
Boulder, Women's International League for Peace and Freedom
Broomfield, Walnut Creek Homeowners' Assoc.
Colorado Springs, Citizens for Peace in Space
Colorado Springs, Pikes Peak Justice and Peace Commission
Denver, American Friends Service Committee
Denver, Clean Water Action
Denver, Colorado Environmental Seminars
Denver, Physicians for Social Responsibility
Denver, Plutonium Issues Committee
Denver, Rocky Mountain Chapter
Englewood, Neighbors in Need
Franktown, The Colorado Coalition
Golden, Sierra Club
Lakewood, Environmental Information Network
Lakewood, Rocky Flats Cleanup Commission
Nederland, Mountain Forum for Peace

District of Columbia

AFL-CIO
Alliance for Nuclear Accountability
Clean Water Action Project
Concern, Inc.
Environmental Defense Fund
Friends of the Earth
Greenpeace
League of Women Voters
National Community Action Foundation
National Trust for Historic Preservation
National Wildlife Federation
Natural Resources Defense Council
Nuclear Control Institute
Peace Action Education Fund
Physicians for Social Responsibility
Plutonium Challenge
The Sierra Club
Union of Concerned Scientists
U.S. Public Interest Research Group
The Wilderness Society

Florida

Tallahassee, National Audubon Society

Georgia

Alto, Action for a Clean Environment
Atlanta, Women's Action for New Directions
Nicholson, Alternatives in Action

Norcross, Southern States Energy Board
Savannah, Citizens for Clean Air and Water
Savannah, Citizens for Environmental Justice
Savannah, Greenpeace U.S.A., Inc.
Stone Mountain, Georgians Against Nuclear Energy (GANE)
Sutee Nacoochee, 20/20 Vision

Idaho

Troy, Environmental Defense Institute

Maryland

Annapolis, Sierra Club, Appalachian Office
Bethesda, The Wildlife Society
Takoma Park, Environmental Action Foundation

Minnesota

Minneapolis, The Nature Conservancy

North Carolina

Chapel Hill, The Nature Conservancy

New Mexico

Albuquerque, Albuquerque Center for Peace and Justice
Albuquerque, All Peoples Coalition
Albuquerque, Citizens for Alternatives to Radioactive Dumping
Albuquerque, Environmental Evaluation Group
Albuquerque, National Parks & Conservation Assn.
Albuquerque, New Mexico Alliance
Albuquerque, South West Research & Information Center
Fairview, New Mexico Alliance
Questa, Rural Alliance for Military Accountability
Santa Fe, Concerned Citizens for Nuclear Safety
Santa Fe, Los Alamos Study Group
Santa Fe, National Audubon Society, New Mexico State Office
Santa Fe, The Nature Conservancy
Santa Fe, New Mexico Environmental Law Center
Santa Fe, People for Peace
Santa Fe, The Sanctuary Foundation

New York

New York, Environmental Defense Fund
Rochester, Women's Action for New Directions

South Carolina

Aiken, Economic Development Partnership
Columbia, Energy Research Foundation
Columbia, League of Women Voters of SC
Hilton Head Island, Resident Home Owners' Coalition
Jackson, Augusta Audubon Society

Tennessee
Oak Ridge, Oak Ridge Environmental Peace Alliance

Virginia
Arlington, Defense Cleanup
Arlington, National Water Resources Association
Virginia Beach, Sierra Club Nuclear Waste Task Force

West Virginia
Wheeling, Urban Energy and Transportation Corporation

State NEPA Contacts

California
Rivasplata, Terry, Governor's Office of Planning & Research, California State Clearinghouse

Colorado
Tarlton, Steve, Colorado Department of Public Health & Environment, Rocky Flats Program

Georgia
Setser, James, Georgia Department of Natural Resources

Illinois
Moreland, Terri, The State of Illinois Office

Kansas
Hammer-Schmidt, Ronald, Kansas Department of Health & Environment

Kentucky
Bickford, James, Kentucky Cabinet for Natural Resources & Environmental Protection
Logan, Bob, Department for Environmental Protection

Missouri
Pohl, Lois, Missouri Federal Assistance Clearinghouse

New Mexico
Weidler, Mark E., New Mexico Environment Department

South Carolina
Burgess, Omeagia, Office of State Budget

Tennessee
Leming, Earl, Tennessee Department of Environment & Conservation
Wilson, Justin P., Tennesee Department of Environment & Conservation

Citizen Advisory Boards

Colorado, Westminster, Holm, Victor, Rocky Flats Citizens Advisory Board
Colorado, Westminster, Marshall, Tom, Rocky Flats Citizens Advisory Board
Colorado, Westminster, Murakami, Linda, Rocky Flats Citizens Advisory Board

Georgia, Savannah, Elfner, Mary, SRS Citizens Advisory Board
New Mexico, Albuquerque, Dompreh, Jesse, SNL Citizens Advisory Board
New Mexico, Los Alamos, Chavira-Merriman, Bernadette, LANL Citizens Advisory Board
New Mexico, Los Alamos, Dubois, Anne, LANL Citizens Advisory Board
New Mexico, Ranchos De Taos, Delgado, Antonio, LANL Citizens Advisory Board
South Carolina, Aiken, Goad, Ken, SRS Citizens Advisory Board
South Carolina, Barnwell, Loadholt, Ann G., SRS Citizens Advisory Board
South Carolina, Beaufort, Mackey, Jimmy, SRS Citizens Advisory Board

News Media

California
Armantrout, Janet, Independent Newspaper
Mayer, Nancy, Tri Valley Herald
Weiss, Peter, Valley Times

Colorado
Avery, Greg, Louisville/Lafayette Times
Banks, Tamara, KWGN-TV
Bell, Jerry, KAO Radio
Day, Paul, KCNC-TV
Editor, Denver Post
Editor, Boulder County Business Report
Fosholt, John, KUSA-TV
Leaf, Bruce, Boulder Daily Camera
McMillin, John, Jeffco Sentinels
Minshall, Dave, KMGH-TV
Moore, Nancy, Inside Energy
Morson, Bernie, Rocky Mountain News
Regensberg, Pam, Longmont Times Call
Serrano, Kelly, Metro North Sentinel
Svaldi, Aldo, Denver Business Journal
Tharp, Linda, Golden Transcript
White, Jeff, Arvada Sentinel

District of Columbia
Lobsenz, George, Energy Daily
Usdin, Steve, Nuclear Remediation Week
Weapons Complex Monitor

New Mexico
McClellen, Doug, Albuquerque Journal North

South Carolina
Burris, Roddie A., Aiken Standard

General Public

California
Berkeley, Bernardi, Gene
Berkeley, Boone, Barry
Berkeley, Casebar, Jami
Berkeley, Chess, Judy

Berkeley, Drotos, Fredrica
Berkeley, Field, Hank
Berkeley, Friend, Gil
Berkeley, Golf, Pat
Berkeley, Hans, Karl
Berkeley, Luton, Dan
Berkeley, Morgan, Nick
Berkeley, Selawsky, John
Berkeley, Sihvola, Pamela
Berkeley, Simon, Dan
Berkeley, Smith, Dale
Berkeley, Thomas, Janice
Berkeley, Wood, L. A.
Davis, Rust, Mary
Davis, Roth, Julie
Davis, Attiga, Salem
Davis, Oatman, Brian
Davis, Tackett, Alice
Hathaway Pines, Williams, Alan K.
Los Angeles, Plotkin, Sheldon C.
Northridge, Raskin, Jerome
Oakland, Charbonneau, Bob
San Diego, Pepin, John G.
Simi Valley, Pinchev, Arthur
Simi Valley, Johnson, Barbara

Colorado

Arvada, Abbott, Bini
Arvada, Edstrom, Carl M.
Arvada, Ellringer, Dave
Arvada, Grillon, Joy
Arvada, Rippetoe, Joe F.
Arvada, Werth, Kenneth
Arvada, Woodis, John
Boulder, Anderson, Carol M.
Boulder, Ackland, Len
Boulder, O'Guin, Becky
Boulder, Rivera, Michael
Broomfield, Wilson, Larry
Denver, Holeman, Tim
Lafayette, Eichelberger, Nadine
Littleton, Kangas, Mark
Louisville, Ferrera, Ken
Morrison, Tempel, Joe
Westminister, Trenary, Alan

Georgia

Alto, Calhoun, Emily B.
Atlanta, Tedder, R. D. W.
Augusta, Cheeves, Aundria D.
Augusta, Jones, Theonious A.
Augusta, Paine College, Lawless, William F.
Augusta, Wilkins, Beaurine H.
Augusta, Zimmerman, Vernon
Martinez, Belge, Arthur
Martinez, May, Kathryn
Savannah, Braut, Kamalakar
Thomson, Simone, Deborah
Tybee Island, Donaldson, Bill

Missouri

Kansas City, Harris, Charles H.

New Jersey
Short Hills, Allan, Peter

New Mexico
Albuquerque, Drez, Paul
Albuquerque, Geddie, John
Albuquerque, Halsaver, Richard
El Prado, Bonneau, Bonnie
Los Alamos, Christensen, Dana C.
Los Alamos, Hoard, Dorothy
Los Alamos, Koch, Steve
Los Alamos, Pendergrass, Ann
Los Alamos, Pillay, Sam
Los Alamos, Robinson, Mark A.
Los Alamos, Smith, Michael
Los Alamos, Stoddard, Steve and Barbara
Los Alamos, Sydoriak, Charisse

Nevada
Las Vegas, Wilcox, Debby

South Carolina
Aiken, McDonell, William
Aiken, Morris, J. W.
Aiken, Patterson, Karen
Barnwell, Gloadholt, Ann
Elko, Jenkins, Brendolyn L.
Graniteville, Parker, Lane D.
Hilton Head Island, Nestor, Jo-Ann
North Augusta, Boettinger, W. L.
North Augusta, Brown, Anne
North Augusta, McWhorter, Donald L.
North Augusta, Smith, Perjetta K.
North Augusta, Street, Gary H.
North Charleston, Tant, J. Ed

Texas
Port Arkansas, Smith, Tom

Virginia
Manassas, Petraglia, Jeff

Washington
Richland, Mishima, Jofu

Wyoming
Lander, Kesselheim, Donn

Public Reading Rooms

(See Appendix A of this EIS)

DOE/EIS - 0277F
August 1998

Final Environmental Impact Statement

on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site

Voiume 2

U.S. Department of Energy
Assistant Secretary for
Environmental Management
Washington, DC 20585

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ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

the Board	Defense Nuclear Facilities Safety Board
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
IDC	Item Description Code
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
Rocky Flats	Rocky Flats Environmental Technology Site
WIPP	Waste Isolation Pilot Plant

Chemicals and Units of Measure

ac	acre
Al/NO_3	aluminum nitrate
BTU	British thermal unit
CDPHE	Colorado Department of Public Health and the Environment
Ci	curie
cm	centimeter
CO	carbon monoxide
ft	foot
g	gram
gal	gallon
ha	hectare
HAN	hydroxylamine nitrate
hr	hour
in	inch
kg	kilogram
km	kilometer
km/sec	kilometers per second
KOH	potassium hydroxide
kW	kilowatt
L	liter
lb	pound
m	meter
m/s	meters per second
M	molar
mg	milligram
mi	mile
mi/sec	miles per second
min	minute
mm	millimeter
mph	miles per hour
mrem	millirem
MWe	megawatts electric
MWh	megawatt hours
n	neutron
nCi	nanocuries
oz	ounce
Pb	lead
PM	particulate matter
ppm	parts per million
rad	radiation absorbed dose
sec	second
yd	yard
yr	year
°C	degrees Celsius
°F	degrees Fahrenheit

Appendix A

Notice of Intent

Federal Register

DEPARTMENT OF ENERGY

Notice of Intent to Prepare an Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site

AGENCY: Department of Energy.
ACTION. Notice of Intent.

SUMMARY: The Department of Energy. (DOE) announces its intent to prepare an Environmental Impact Statement (EIS) pursuant to the National Environmental Policy Act (NEPA), in accordance with the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA and the DOE NEPA implementing regulations. This EIS will evaluate the potential environmental impacts associated with reasonable management alternatives for certain plutonium residues and all scrub alloy currently being stored at the Rocky Flats Environmental Technology Site In Golden, Colorado. The residues and scrub alloy are materials that were generated during the separation and purification of plutonium, or during the manufacture of plutonium-bearing components for nuclear weapons. Due to the risk they present, DOE previously decided to stabilize and repackage the plutonium residues at the Rocky Flats Site for safe interim storage as discussed in the Solid Residue Treatment, Repackaging, and Storage Environmental Assessment/Finding of No Significant Impact. The activities analyzed In this EIS would be in addition to certain activities described in the Solid Residue Environmental Assessment by subjecting a portion of those residues to further treatment to prepare them for disposal or other disposition. This EIS will also analyze management activities for scrub alloy. This notice describes the proposed scope of the EIS and requests that members of the public submit comments regarding the scope of the EIS. Comments may be submitted in writing at the public scoping period and orally during public scoping meetings as described below.

DATES: The public scoping period begins with the publication of this notice and will continue until December 19, 1996. Written comments postmarked by that date will be considered In preparation of the EIS. Comments postmarked after that date will be considered to the extent practicable.

Public Scoping meetings will be held at the locations and times specified below. This information will also be announced in local public notices before the planned meetings.

Meeting.- Rocky Flats Environmental Technology Site.

Date: Tuesday, December 3, 1996.

Time: 6:30 PM to 9:30 PM.

Location: Rocky Flats Environmental Technology Site, Building 060 (Outside the West Gate), State Highway 93, Golden, Colorado 80402.

Contact for the Golden Meeting: Mr. Mike Konczal, Telephone: (303) 966- 5993.

Meeting: Savannah River Site.

Date: Thursday, December 12, 1996.

Time: 6:30 PM to 9:30 PM.

Location: North Augusta Community Center, 101 Brookside Drive, North Augusta, South Carolina 29841, (803) 441-4290.

Contact for the North Augusta Meeting: Mr. Andrew R. Grainger, Telephone: 1-800-242-8269.

ADDRESSES: Written comments on the scope of the Rocky Flats Plutonium Residues and Scrub Alloy EIS, including issues to be addressed, questions about the plutonium residues, and/or requests for copies of the draft EIS should be sent to the following address: Mr. Charles R. Head, Office of Nuclear Material and Facility Stabilization (EM-60), United States Department of Energy, I 000 Independence Avenue, S.W., Washington, D.C. 20585, Telephone: 202-586-9441, Facsimile: 202-586- 5256.

Members of the public who request a copy of the draft EIS should specify whether they would like a copy of the entire draft EIS (which will consist of multiple bound volumes), or if they would prefer a copy of the Summary of the draft EIS (which will be a bri2f single volume).

FOR FURTHER INFORMATION CONTACT: For further information on the Rocky Flats Plutonium Residues and Scrub Alloy EIS, please contact Mr. Charles R. Head at the address specified above under the heading ADDRESSES.

For general information on the DOE NEPA review process, please contact: Ms. Carol Borgstrom, Director, Office of NEPA Policy and Assistance (EH-42), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, D.C. 20585, Telephone: 202-586-4600 or leave a message at 800-472-2756.

Addresses of reading rooms where additional Rocky Flats Plutonium Residues and Scrub Alloy EIS information Is available are listed below in the section entitled "Public Scoping Process".

SUPPLEMENTARY INFORMATION: DOE announces Its intent to prepare an Environmental Impact Statement pursuant to the National Environmental Policy Act (NEPA) (42 U.S.C. 5 432 1, *et seq.),* in accordance with the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508) and the DOE NEPA implementing regulations (IO CFR Part 102 1) to evaluate reasonable alternatives for management of certain plutonium residues and all of the scrub alloy at the Rocky Flats Site in Golden, Colorado. Plutonium residues and scrub alloy are materials that were generated while processing plutonium during the manufacture of components for nuclear weapons. The management alternatives to be analyzed include treatment of these materials to enable them to be disposed of as waste or, for some surplus weapons-usable material, otherwise dispositioned.

Purpose and Need

Stabilization activities to mitigate the risks associated with the current storage condition of plutonium residues (e.g., deteriorating and overpressurized storage containers, and ignitability concerns) are in progress at the Rocky Flats Site based on the decisions resulting from the Solid Residue Treatment, Repackaging, and Storage

Environmental Assessment/Finding of No Significant Impact, issued in April 1996 (DOE/EA- 1 120, the "Solid Residue Environmental Assessment'). The Solid Residue Environmental Assessment addressed the potential environmental impacts associated with stabilizing the entire 106,600 kg inventory of Rocky Flats Site plutonium residues to allow its safe interim storage until the final disposition of the residues could be decided upon and implemented. However, due to the need for expeditious action to resolve problems with storage of the plutonium residues at Rocky Flats, the Solid Residues Environmental Assessment did not address disposal or other disposition of the residues after these materials were stabilized. Decisions regarding treatment of these materials for purposes other than stabilization, i.e., disposal or other disposition,[1] will require the evaluation of several treatment technologies and thus were considered to require a lengthier and more complex evaluation process than could be completed in time to meet the more immediate need to make and implement stabilization decisions.

DOE has determined that, even after stabilization, approximately 42,300 kg of the total of about 106,600 kg of plutonium residues currently in storage at Rocky Flats would remain in forms that, although not directly weapons usable, would contain sufficiently high concentrations of plutonium so as to not meet the safeguards termination I requirements for disposal.[2] Because of the plutonium concentration and the relative ease with which plutonium could be recovered from the residues, such residues could be attractive to terrorist organizations as a source of plutonium (about 2,600 kg could be separated from the Rocky Flats residues and scrub alloy) for use in nuclear weapons or other terrorist devices. Diluting these materials could reduce the plutonium concentrations sufficiently to meet disposal requirements but, for many samples of the residues, probably would yield an extremely large waste volume that would be very costly to transport and dispose of. Therefore, in addition to dilution, alternatives need to be considered, such as treatments that would either bind the plutonium in a matrix from which it would be difficult to extract, or treatments that would separate the plutonium from the remaining constituents of the residues and scrub alloy. Any separated plutonium would not be used for nuclear weapons purposes, but would be safely stored in secure facilities with other similar materials, pending disposition (see footnote 1). Whenever feasible, DOE would offer such storage facilities to be placed under International Atomic Energy Agency (IAEA) safeguards. For the other 64,300 kg of plutonium-bearing residues currently in storage at the Rocky Flats Site, the activities discussed in the Solid Residue Environmental Assessment will meet the transuranic waste disposal and safeguards termination requirements and will not be addressed in this EIS.

This EIS will evaluate reasonable management alternatives for the approximately 42,300 kg of plutonium residues discussed above, including treatment of the material to a form and concentration that is suitable for disposal or other disposition. Evaluation of these alternatives at this time will facilitate planning for disposal or other disposition, and allow any additional treatment to be integrated with the on- going stabilization process so that handling the material can be minimized (i.e., by avoiding potential double handling). Minimizing such handling would reduce the worker risk associated with achieving a material form suitable for disposal or other disposition.

In addition to the residues discussed above, approximately 700 kg of scrub alloy (predominately a magnesium/ aluminum/americium/plutonium metal mixture) currently in storage at the Rocky Flats Site, containing about 200 kg of plutonium, also needs treatment before being suitable for disposal or other disposition. Due to similarities in the issues related to the management of the scrub alloy and the plutonium residues, management alternatives for the scrub alloy will also be analyzed in this EIS.

The entire inventory of plutonium residues currently stored at Rocky Flats is included in the Draft Waste Management Programmatic Environmental Impact Statement (WMPEIS) under the assumption that it may be managed as transuranic waste. The WMPEIS analyzes storage and treatment configurations (i.e., centralized, regionalized and decentralized treatment and storage) for transuranic wastes, including the Rocky Flats plutonium residues. The analysis of alternatives In this EIS will take into account the analyses of alternatives in the WMPEIS and the decisions made In any Records of Decisions that may result from those analyses.

Background

Plutonium residues and scrub alloy were generated by processes used to recover and purify plutonium and manufacture components for nuclear weapons. Approximately 125,000 kilograms (kg) of residues (containing about 5,800 kg of plutonium) and approximately 700 kg of scrub alloy (containing about 200 kg of plutonium) are currently stored at various DOE sites. Of these totals, approximately 106,600 kg of the residues (containing about 3,000 kg of plutonium), and nearly all of the scrub alloy are stored in various types of containers in six former plutonium production facilities at the Rocky Flats Site. The remaining approximately 18,400 kg of plutonium residues are stored at the Savannah River Site in South Carolina, the Hanford Site in Washington, Los Alamos National Laboratory in New Mexico, and Lawrence Livermore National Laboratory in California. About 6 kg of scrub alloy are stored at the Savannah River Site. Stabilization activities for the approximately 18,400 kg of plutonium residues and 6 kg of scrub alloy not located at the Rocky

[1] After treatment, the Rocky Flats residues and scrub alloy could be disposed of as transuranic wastes or, depending on the treatment, could be transformed or chemically altered so as to concentrate the plutonium for other disposition (see below). "Transuianic" refers to elements, such as plutonium, that have an atomic number greater than that of uranium. The disposal of transuranic waste at the Waste isolation Pilot Plant (WIPP) is being analyzed In the Draft Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement. DOE is developing WIPP, near Carlsbad, New Mexico. as a potential disposal facility for transuranic wastes. DOE is evaluating the disposition of weapons-usable plutonium, which would be relevant if the residue or scrub alloy materials were treated to separate the plutonium from other constituents. Such potential uses include using the plutonium In mixed oxide fuel for power reactors. immobilization, and disposal in a deep borehole.

As a result of the potential for disposal of these materials at WIPP, "disposal requirements" for the residues and scrub alloy refers to the Planning Basis Waste Acceptance Criteria for WIPP (or alternative treatment level, depending on decision in the Record of Decision for the WIPP SEIS ID, and any other requirements that must be met to allow disposal, such as safeguards termination requirements. Requirements for other disposition will be developed as part of detailed NEPA analyses that will be tiered from the Storage and "position of Weapons-Usable Fissile Materials Programmatic Environmental impact Statement (draft issued by DOE in February 1996; also see item 6 under "Related NEPA Documentation" in this Notice).

[2] Materials that could be used to fuel nuclear weapons (e.g., Uranium-235 or Plutonium-239) are required to be placed under a system of controls and protections to ensure that they are not misused or lost. This system of controls and protections is referred to as "safeguards." In general, wastes that contain large enough concentrations of nuclear weapons-usable materials cannot be disposed of unless actions (such as reducing the concentration of nuclear weapons usable materials, or immobilizing such materials so that they would be exceptionally difficult to recover) are taken that make it no longer necessary to "safeguard" them. The requirements that define the state into which such wastes must be converted in order for them no longer to require "safeguards" are referred to as "safeguards termination requirements".

Flats Site are analyzed in NEPA reviews that have already been completed or are currently underway. These reviews are listed and summarized in the section of this notice titled "Related NEPA Documentation." The final approximately 5 kg of plutonium residues are located at several DOE sites. each having an inventory of less than I kg. Treatment options for these plutonium residues have been identified or are in the process of being defined by the managements of the installations at which these residues are stored. The plutonium residues at the Rocky Flats Site that require treatment beyond stabilization prior to disposal or other disposition consist of four categories: ash, salts, wet residues, and direct repackage residues. The residues are grouped into these categories due to chemical similarities or similarities in the manner in which they could be managed. All these residue categories and scrub alloy will be discussed in this EIS and are briefly described below. The approximate quantities in each category requiring treatment beyond stabilization to prepare them to meet the requirements for disposal or other disposition are noted.[3]

1. Ash Residues. The ash residue category consists of approximately 28,000 kg of material containing approximately 1, I 00 kg of plutonium in three basic groups. Examples from each group are: (a) Incinerator ash, firebrick heels and fines, and soot; (b) pulverized sand, slag and crucible; and (c) graphite fines. Approximately 71 percent of the ash residue inventory (-19,900 kg) would require treatment beyond stabilization for disposal in WIPP or other disposition.

2. Salt Residues. The salt residue category consists of about 16,000 kg of material containing approximately 1,000 kg of plutonium and can be further sub- divided into three groups:
electrorefining salts, molten salt extraction salts, and direct oxide reduction salts. These salts consist primarily of sodium chloride, potassium chloride and magnesium chloride. Approximately 93 percent of the salt residue inventory (-14,900 kg) would require treatment beyond stabilization for disposal in WIPP or other disposition.

3. Wet Residues. The wet residues consist of approximately 17,000 kg of material containing approximately 600 kg of plutonium and are made up of a disparate assembly of materials, such as wet (aqueous and organic contaminated) combustibles, plutonium fluorides, high efficiency particulate air filter media, sludges and Raschig (glass) rings. Approximately 26 percent of the wet residue inventory (-4,400 kg) would require treatment beyond stabilization for disposal in WIPP or other disposition.

4. Direct Repackage Residues. The direct repackage residue category consists of about 39,000 kg of material, containing about 300 kg of plutonium, and comprises those plutonium residues that are considered to be stable and do not require stabilization for storage. These residues consist of materials such as paper, rags, cloth, plastic, personal protective equipment, and gaskets. Approximately 8 percent of the direct repackage residue (-3. 1 00 kg) would require treatment for disposal in WIPP.

5. Scrub Alloy. Scrub alloy is predominately a magnesium/aluminum/ americium/plutonium metal mixture that was created as an interim step in plutonium recovery. The entire Rocky Flats scrub alloy inventory of approximately 700 kg, containing approximately 200 kg of plutonium, will require treatment to put it in a form that would meet the requirements for disposal in WIPP or other disposition.

Preliminary Alternatives

Discussed below are the preliminary alternatives identified for management of certain Rocky Flats Site plutonium residues (approximately 42,300 kg) and scrub alloy (approximately 700 kg), including transportation to reasonable treatment sites and treatment to prepare them for disposal or other disposition. DOE welcomes comments on these or other reasonable alternatives and on the identification of a preferred alternative.

Alternative I -No Action: The No Action alternative consists of ongoing residue storage activities, and activities addressed in the Solid Residue Treatment, Repackaging, and Storage Environmental Assessment/Finding of No Significant Impact, plus the on-site storage of the scrub alloy inventory in its current form. Under the No Action alternative, stabilization, repackaging, and monitoring of the entire plutonium residue inventory for safe interim storage would continue. Interim storage would be in containers and under conditions appropriate for a period of approximately 20 years, with approximately 64,300 kg of the residues prepared for waste disposal. The other 42,300 kg of plutonium residues and the scrub alloy would remain in a form that is not suitable for disposal as waste, or other disposition.

Alternative 2-On-Site Treatment: This alternative would involve treatment at the Rocky Flats Site, as discussed below:

a. Treatment Without Plutonium Separation-This alternative includes treating the plutonium residues or scrub alloy to prepare the material for disposal as waste without removal of the plutonium. This treatment alternative would use techniques such as immobilization, (e.g., ceramification or vitrification), or dilution by blending with other matrix materials (e.g., blending the salt residues with depleted uranium oxide or additional salt). The resulting waste form would meet the planning basis waste acceptance criteria for disposal in WIPP. The material would no longer be attractive as a potential source of plutonium since it would be in a physical and chemical form from which it would be difficult to recover the plutonium, or the resulting material would have too low a concentration of plutonium. However, the dilution approach would result in substantially greater amounts of transuranic waste.

b. Treatment With Plutonium Separation—Plutonium separation would consist of removing the plutonium from the residue or scrub alloy. Plutonium separation would generate two distinct forms of material; a treated waste form and a plutonium metal or oxide. The treated waste would meet the planning basis waste acceptance criteria for disposal in WIPP. The plutonium metal or oxide would be in a form that would be suitable for disposition in accordance with the decisions resulting from the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS. The Rocky Flats Plutonium Residues and Scrub Alloy EIS will include analysis of any actions needed to manage separated plutonium until the decisions resulting from the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS are implemented. Under this treatment alternative, there would be no need to dilute the plutonium-bearing materials to allow them to meet transuranic waste disposal requirements, although other types of waste would be produced that are more easily disposed of. [4] The recovered

[3] As noted previously in this Notice. a total of approximately 106,600 kg of plutonium residues is currently in storage at Rocky Flats. Of this total, approximately 6,6W kg is in a residue category designated "Classified Shapes" that does not require treatment beyond that analyzed in the Solid Residue Environmental Assessment. This leaves approximately I 00.000 kg of residues in the four listed categories, 42,300 kg of which will need additional treatment beyond that analyzed in the Solid Residue Environmental Assessment. The scrub alloy is not a plutonium residue, and thus is not included in the 100,000 kg residue total

[4] Both low-level radioactive and hazardous wastes could be generated as a result of such treatment. Any hazardous wastes would be sent to a licensed

plutonium could not be used for nuclear explosive purposes under the DOE Secretarial policy established in December 1994.5

Alternative 3-Off-Site Treatment: Under this alternative, the plutonium residues or scrub alloy would be treated off-site using various treatment technologies, with or without plutonium separation, as discussed under Alternative 2 above. The plutonium residues might require pre- treatment at Rocky Flats to modify the material composition and physical packaging so that the material would be in a condition suitable for transportation. Potential locations for off-site treatment include: the Savannah River Site, the Los Alamos National Laboratory (LANL), and the Lawrence Livermore National Laboratory (LLNL). The Savannah River Site has the capability to treat most residues and all scrub alloy efficiently. LANL and LLNL each have facilities that could treat only part of the salt residues (about 13,400 kg), but at much slower rates than treatment at the Savannah River Site. The cost of treatment at LANL and LLNL Is expected to be slightly higher than the cost of treatment at the Savannah River Site. None of these facilities, including the Rocky Flats Site, currently is capable of treating all of the ash residues. Further, treatment at LANL and LLNL may be difficult to accommodate in light of the other missions of those sites. Taking account of all these circumstances, the Savannah River Site appears to be a more likely offsite location for treating the Rocky Flats plutonium residues and scrub alloy than LANL or LLNL. Nevertheless, DOE cannot rule out the possibility that further analysis or changing circumstances might provide reasons to treat some of these materials at LANL or LLNL.

Any plutonium that might be separated under the "Treatment With Plutonium Separation" option would be placed in storage pending implementation of decisions made after completion of the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS. As specified for Alternative 2.b above, the Rocky Flats Plutonium Residues and Scrub Alloy EIS will include analysis of any actions needed to manage separated plutonium until the decisions made after completion of the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS are Implemented.

commercial treatment, storage and disposal facility. Any low-level radioactive wastes would be disposed of along with other low-level radioactive wastes generated at the Rocky Flats Site.

5 Such plutonium would be stabilized, packaged for storage (under DOE safe storage criteria suitable for 50 years) and would be stored at Rocky Flats pending implementation of storage and disposition decisions. While In storage, the plutonium metal/ oxide would remain safe and in a secured facility.

Public Scoping Process

To ensure that the full range of issues related to the Rocky Flats Plutonium Residues and Scrub Alloy EIS is addressed, comments on the proposed scope of the EIS are invited from all interested parties during the scoping period. Written comments should be directed to Mr. Charles R. Head at the address indicated above under the heading ADDRESSES. Agencies, organizations, and the general public are also invited to present oral comments at the public scoping meetings to be held at the times and dates listed in the DATES section above.

Written and oral comments will be given equal consideration. Individuals desiring to speak at a public scoping meeting (or meetings) should pre- register by telephoning or writing the contact person(s) designated for the meeting as specified above in the DATES section of this Notice. Pre-registration should occur at least four days before the designated meeting. Persons who register at the meeting will be called on to speak as time permits, after the pre-re istered speakers.

To ensure that everyone has an adequate opportunity to speak, each speaker at a scoping meeting will be allotted five minutes. Depending on the number of persons who request an opportunity to speak, more time may be allowed for speakers representing several parties or organizations. Persons wishing to speak on behalf of organizations should identify the organization in their request. Written comments also will be accepted at the meetings, and speakers at scoping meetings are encouraged to provide written versions of their oral comments for the record.

DOE will record and prepare transcripts of the oral comments received during the public scoping meetings. Interested persons will be able to review the transcripts, written comments, reference material, related NEPA documents, and background information during normal business hours at the following locations:

U.S. Department of Energy, Freedom of Information Room, Room IE-190, Forrestal Building, 1000 Independence Avenue, S.W., Washington, D.C. 20585, Telephone: 202-586-6020

U.S. Department of Energy, Public Reading Room, Gregg Graniteville Library, 171 University Parkway, Aiken, South Carolina 29801, Telephone: 803-641-3465

County Library, 2002 Bull Street, Savannah, Georgia 31299-430, Telephone: 912-234-5127

County Library, 404 King Street, Charleston, South Carolina 29403, Telephone: 803-723-1645

Rocky Flats Citizens Advisory Board, Public Reading Room, 9035 Wadsworth Avenue, Suite 2250, Westminster, Colorado 8002 1, Telephone: 303-420-7855

Standley Lake Public Reading Room, 8485 Kipling Street, Arvada, Colorado 80005, Telephone: 303-456-0806

U.S. Department of Energy, Golden Field Office, Public Reading Room, 14869 Denver West Parkway, Golden, Colorado 80401, Telephone: 303-275- 4742

U.S. EPA Superfund Records Center, 999 18th Street, 5th Floor, Denver, Colorado 80202-2405, Telephone: 303-312-6473

Colorado Department of Public Health and Environment, Information Center, 4300 Cherry Creek Drive South, Denver, Colorado 80222, Telephone: 303-692-2037

Rocky Flats Public Reading Room, Front Range Community College Library, 3645 West 112th Avenue, Westminster, Colorado 80030, Telephone: 303-469-4435

Albuquerque Operations Office, National Atomic Museum, 20358 Wyoming Blvd. S.E., Kirtland Air Force Base, P.O. Box 5400, Albuquerque, New Mexico 87185- 5400, Telephone: 505-845-4378

Los Alamos Community Reading Room, 1450 Central, Suite 101, Los Alamos, New Mexico 87544, Telephone: 505- 665-2127

Lawrence Livermore National Laboratory, East Gate Visitors Center, Greenville Road, Livermore, California 94550, Telephone: 5 1 0- 424-4026

Oakland Operations Office, U.S. Department of Energy, Public Reading Room, EIC, Bth Floor, 1301 Clay Street, Oakland, California 94612- 5208, Telephone: 510-637-1762

DOE plans to issue the draft EIS In the Spring of 1997. DOE will announce availability of the draft in the Federal Register and other media, and will provide the public, organizations, and agencies with an opportunity to submit comments. These comments will be considered and addressed in the final EIS, scheduled for issuance in the Fall ofl997.

Preliminary Issues: DOE has preliminarily identified the

environmental issues listed below for analysis in the Rocky Flats Plutonium Residues and Scrub Alloy EIS. This list is presented to facilitate discussion concerning the scope of the EIS and is not intended to exclude consideration of other pertinent Issues that may be suggested during the scoping period or to predetermine the scope of the EIS. DOE invites comments on these and any other issues relevant to the analysis in the EIS. The environmental issues identified by DOE are as follows:

1. Public and Occupational Safety and Health: The potential radiological and non-radiological Impacts of the management alternatives for the plutonium residues and scrub alloy, including projected effects on workers and the public from routine operations and potential accidents at the Rocky Flats Site, Savannah River Site, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory, and along transportation routes from the Rocky Flats Site to the other sites.

2. Environmental Media: Potential impacts on soil, water, and the air.

3. Sensitive Environmental Resources: Potential impacts on plants, animals, and habitat, including impacts to flood plains, wetlands, and threatened and endangered species and their habitat.

4. Resource Consumption: Potential impacts from consumption of natural resources and energy, including water, natural gas, and electricity.

5. Socioeconomic: Potential impacts on local communities, including labor force employment and support services.

6. Environmental justice: Potential for disproportionately high and adverse impacts of DOE activities on minority and low-income populations.

7. Cultural Resources: Potential impacts on cultural resources, such as historic, archaeological, scientific, or culturally important sites.

8. Regulatory Compliance: The impacts of the alternatives on compliance of the Rocky Flats Site, Savannah River Site, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory with applicable Federal and state laws and regulations.

9. Cumulative Impacts: The impacts of these alternatives in conjunction with other past, present and reasonably foreseeable future actions regardless of agency (Federal or non-federal) or persons undertaking such other actions. 10. Potential Irreversible and Irretrievable Commitment of Resources: The potential irreversible and irretrievable commitment of resources that would be involved in each alternative.

I 1. Non-Proliferation and International Plutonium-processing Policy: The potential impacts to international policy regarding the non- proliferation of nuclear weapons and processing of plutonium that would be involved with the alternatives involving separation of plutonium.

Related NEPA Documentation: Documents that have been or are being prepared that may relate to the scope of the Rocky Flats Plutonium Residues and Scrub Alloy EIS include the following:

*12. Solid Residue Treatment, Repackaging, and Storage Environmental Assessment (DOE/EA-*II 20) and Finding of No Significant Impact, issued April 1996. This Environmental Assessment addressed the stabilization of the plutonium residue inventory currently at the Rocky Flats Site. The actions being implemented based on the Environmental Assessment are included in the No Action alternative of the Rocky Flats Plutonium Residues and Scrub Alloy Environmental Impact Statement.

13. Rocky Flats Site-%!de Environmental Impact Statement Notice of Intent (59 FR 4001 1. August 5, 1994). This Notice announced DOE's intention to prepare a site-wide EIS for the Rocky Flats Environmental Technology Site. In a Federal Register Notice dated July 17, 1996, DOE deferred completion of the Site-wide EIS pending the completion of a new cleanup agreement (since completed) with the Environmental Protection Agency and the State of Colorado and decisions that may result from issuance of the WM PEIS (see item 5, below).

14. Interim Storage of Plutonium at the Rocky Flats Environmental Technology Site Environmental Impact Statement Notice of Intent (61 FR 37247, July 17, 1996). This Notice announced DOE's intention to prepare an environmental impact statement to evaluate the alternatives for providing safe interim storage of approximately 10 metric tons of plutonium at the Rocky Flats Environmental Technology Site pending implementation of decisions based on the Storage of Disposition of Weapons-Usable Fissile Materials Programmatic EIS. Any plutonium that would be separated through the treatment at Rocky Flats of residues and scrub alloy would be stored in accordance with decisions that may. result from the analysis in the Interim Storage of Plutonium at the Rocky Flats Environmental Technology Site EIS, pending implementation of decisions based on the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS.

*15. Draft Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement (DOE/*EIS-0026-S2). This is the second supplemental EIS for WIPP, a DOE research and development project that is proposed for the disposal of transuranic wastes. The Department's proposed action is to dispose of transuranic waste at the facility. The Notice of Intent for the second supplemental EIS was issued on August 23, 1995 (60 FR 43779). The Rocky Flats plutonium residues (including transportation to WIPP) are considered in the scope of the supplemental EIS. The draft supplemental EIS is scheduled to be issued in late 1996 and the final supplemental EIS and Record of Decision are scheduled to be issued in the Summer of 1997. The Rocky Flats Plutonium Residues and Scrub Alloy EIS will be prepared in coordination with the WIPP supplemental EIS.

16. Draft Waste Management Programmatic Environmental Impact Statement (WMPEIS) (DOE/EIS-0200-D, August 1995). The WMPEIS considers alternative approaches for consolidating the management of the Department of Energy's low-level, low-level mixed, hazardous, transuranic, and high-level waste. Records of Decision based on the WMPEIS are scheduled to be issued starting in 1997 and will be made by waste type. The Rocky Flats Phutonium Residues and Scrub Alloy EIS will be prepared in coordination with the WMPEIS and applicable records of decision that may be issued before completion of this EIS.

17. Draft Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement (DOE/EIS-0229-D, February 1996). This Programmatic EIS analyzes the potential environmental impacts associated with approaches to storage and disposition of the Department's weapons-usable fissile materials, including plutonium. Under the No Action alternative, Rocky Flats plutonium metals and oxides, including any plutonium metals or oxides generated as part of plutonium residue treatment, would remain at Rocky Flats. Under all other alternatives, stabilized weapons-usable Rocky Flats material would be transferred to another DOE site. The treatment alternatives discussed in this Notice of Intent that involve separation of plutonium would generate weapons-usable plutonium metals and oxides that would be stored and dispositioned according to decisions made based on the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS. The final Storage and Disposition of

Weapons-Usable Fissile Material Programmatic EIS is scheduled to be issued in late 1996.

18. Final Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory (DOE/EIS-0 1 57, August 1992, the "LLNL Site-wide EIS"). This document analyzes the potential environmental impacts of a proposed action to continue operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore. The LLNL site-wide EIS also analyzes the potential environmental impacts associated with a no-action alternative involving continuing operations at FY 1992 funding levels without further growth, an alternative to modify operations to reduce adverse environmental impacts of operations or facilities, and a shutdown and decommissioning alternative. The Record of Decision for the LLNL Site-wide EIS (58 FR 6268, January 27, 1993) announced that DOE had decided to continue the operation of LLNL and Sandia National Laboratories, Livermore, including near- term (within 5 to 10 years) proposed projects. This action included current operations plus programmatic enhancements and facility modifications required to support the research and development rnissions established for the Laboratories by Congress and the President. The alternatives to be analyzed in the Rocky Flats Plutonium Residues and Scrub Alloy EIS that would involve treatment of a portion of the Rocky Flats plutonium residues at LLNL will represent activities beyond those considered in the LLNL Site-wide EIS.

19. *Los Alamos National Laboratory Site-wide EIS Notice of Intent* (60 FR 92:25697-8, May 12, 1995). This notice announced DOE's intention to prepare a Site-wide EIS to address operations and planned activities at the Los Alamos National Laboratory foreseen in the next 5 to 10 years. DOE anticipates that this EIS will provide an analysis of all activities at LANL and all DOE land management activities related to operations at LANL. The draft LANL Site-wide EIS is scheduled to be issued in mid- 1997. The alternatives to be analyzed in the Rocky Flats Plutonium Residues and Scrub Alloy EIS that would involve treatment of a portion of the Rocky Flats plutonium residues at LANL will be prepared in coordination with the analyses being performed for the LANL Site-wide EIS.

20. Plutonium Finishing Plant Stabilization Environmental Impact Statement (DOE/EIS-0244, May 1996). This EIS addressed the potential environmental impacts associated with alternative technological processes at the Hanford Site for stabilizing plutonium-bearing materials, including plutonium residues. In the Record of Decision for this EIS (61 FR 36352, July 10, 1996), DOE decided that the plutonium residues having a low plutonium content (less than 50 weight percent) and meeting criteria established by DOE will be immobilized at the Plutonium Finishing Plant through a cementation process and stored pending disposal. This EIS provided the NEPA analyses required for management of the plutonium residues currently stored at the Hanford Site.

2 *1. Interim Management of Nuclear Materials at the Savannah River Site Environmental Impact Statement (DOE/* EIS-0220, the IMNM EIS). The IMNM EIS addressed the potential environmental impacts associated with alternatives that the Department could implement to stabilize a variety of nuclear materials that are at the Savannah River Site for improved safety or to convert them to another form to support the Department's programs. This analysis also included an evaluation of the alternatives for the treatment of approximately 1,000 kg of plutonium residues and approximately 6 kg of scrub alloy (discussed in IMNM EIS Section 2.3.3, "Plutonium and Uranium Stored in Vaults"), some of which originated at Rocky Flats Site and is currently in storage at the Savannah River Site. Three Records of Decision have been issued for the IMNM EIS (60 FR 65300, December 19, 1995; 61 FR 6633, February 21, 1996; and 61 FR 48474, September 13, 1996), each covering different materials. The decision regarding the plutonium residues and scrub alloy, specified in the first Record of Decision, was to process these materials through the canyon facilities to a form that meets the DOE storage criteria (DOE-STD-3013-94) and to store the plutonium at the Savannah River site.

Issued in Washington, D.C. on this 15th day of Novernber, 1996.

Peter N. Brush,

Acting Assistant Secretary, Environment, SafetyandHealth.

[FR Doc. 96-29650 Filed 11-15-96; 12:52 PM]

BILUNG CODE 645"1-P

Appendix A

Notice of Availability

DEPARTMENT OF ENERGY

Draft Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site

AGENCY: Department of Energy.
ACTION: Notice of availability.

SUMMARY'. The Department of Energy (DOE) announces the availability of the Draft Environmental impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stared at the Rocky Flats Environmental Technology Site (draft EIS) for public review and comment. The Department has prepared this draft EIS pursuant to the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321, et *seq.),* in accordance with the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR parts 1500-1508) and the DOE TN'EPA implementing regulations (10 CFR part 1021). The draft EIS analyzes reasonable alternative means of processing certain plutonium residues and all of the scrub alloy currently stored at the Rocky Flats Site near Golden, Colorado to a form suitable for disposal or other disposition. Plutonium residues and scrub alloy are materials that were generated during the manufacture of components for nuclear weapons. DOE will bold three public hearings during the comment period, which ends January .1i. I 998.

ADDRECSES: Requests for copies of the draft EIS should be directed to: Center for Environmental Management Information, P.O. Box 23769, Washington, D.C. 20025-3769, 1-800- 736--3282 or in Washington. D.C., 202- 863-5084. Copies of the draft EIS are also available for public review at the locations listed at the end of this Notice.

Written comments an the draft EIS should be mailed to: Mr. Chules R. Head, U.S. Department of Energy. Office of Environmental Management (EM--60), 1000 Independence Avenue, SW. Room 5B--085. Washington. DC 20585--0001. Comments may also be submitted to RFPR.EISCEM.DOE.GOV by E-mail.

FOR FURTHER INFORMANON CONTACT: For further information about the draft EIS and about plutonium residues and scrub alloy, contact- Mr. Charles Head at the above address or call (202) 586--5151.

For information on the DOE NEPA process, contact: Carol M. Borgstrom, Director, Office of NEPA Policy and Assistance, U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585--0001, (202) 586- 4600 or leave a message at 1-800-472- 2756.

DATES: The comment period ends on January 5, ig98. Comments postmarked after that date will be considered to the extent practicable. DOE will hold public hearings as follows:

Golden, Colorado-December 10, 1997 Los Alamos, New Mexico--December 11,1997

Augusta, Georgia-December 16, 1997 Further details on the hearings are provided under SUPPLEMENTAL INFORMATION.

SUPPLEMENTARY INFORMATION' Background

On November i9. 199S. DOE published a Notice of Intent (NOI) in the Federal Register (61 FR 58856) to prepare an EIS on the management of certain plutonium residues and scrub alloy stored at the Rocky Flats Environmental Technology Site. The plutonium residues and scrub alloy were generated as intermediate products or products resulting from the manufacture of components for nuclear

weapons. Now that nuclear weapons manufacturing and processing activities

at Rocky Flats have ceased, the plutonium residues and all o the scrub alloy currently stored at the Rocky Flats Site to address health and safety concerns raised by the Defense Nuclear Facilities Safety Board in its Recommendation 94-i. and to prepare these materials for offsite disposal or other disposition, while supporting site closure and limiting worker exposure and waste production. The proposed action is to process the plutonium residues and scrub allay in preparation for disposal or other disposition.

The materials addressed in this draft EIS include approximately 40% of the 106,600 kg (235,000 lb) existing inventory of Rocky Flats plutonium residues, and also the entire inventory of Rocky Flats scrub alloy. The covered material consists of 42.200 kg (93,000 lb) of plutonium residues (containing 2,600 kg (5,730 lb) of plutonium) and 700 kg (1,540 lb) of scrub alloy [containing 200 kg (440 lb) of plutonium]. The remaining Rocky Flats plutonium re idue3 will meet the requirements for disposal after being processed as discussed in DOE's Solid Residues Environmental Assessment (DOEIEA-1120, April 1996), and are not addressed in the draft EIS.

Alternatives Considered

The draft EIS evaluates reasonable processing alternatives that could be applied in the 1998-2004 time frame. Three alternatives are analyzed for each residue category and the scrub alloy:

Alternative I-No Action
Alternative 2-Procewing without Plutonium Separation
Alternative 3-Frocessing with Plutonium Separation

Any plutonium separated from the plutonium residues and scrub alloy as a result of the proposed action would be placed into safe and secure storage pending disposition by immobilization or conversion to mixed-oxide fuel in accordance with decisions to be made under DOE's Surplus Plutonium Disposition Environmental Impact Statement (62 FR 28009, May 22, 1997). The processing technology options for each material category analyzed in the draft EIS include those that can be accomplished at Rocky Flats, and those for plutonium separation only that can be accomplished offsite at the Savannah River Site, near Aiken, South Carolina, and/or at Los Alamos National Laboratory in Los Alamos, New Mexico.

Invitation To Comment

The public is invited to submit written and oral comments on any or all portions of the draft ETS. DOE especially welcomes comments on the following topics: the technical adequacy of the document. the alternatives that DOE should select upon completion of the document-, and the criteria that DOE should use in making these selections.

Public Hearings and Procedures

DOE will hold three public hearings according to the schedule provided at the end of this section. The hearing format will provide for collection of written and oral comments and will enable the public to discuss issues and concerns with DOE staff. Participants who wish to speak at the hearings are asked to register in advance by calling toll-ftee- 1-800-736-3282. Requests to speak that have not been submitted prior to the hearings we be handled in the order in which they are received during the meetings. DOE's responses to comments received during the public comment period will be presented in the final EIS.

An independent facilitator will open the hearings by explaining the format to be followed. The hearings will be conducted in a manner that is intended to foster a cordial, open and mutually beneficial dialog between the participants and the DOE representatives. In the interests of achieving this goal, DOE representatives may ask clarifying questions regarding statements made at the hearings, will answer questions from the public, and may comment on statements made by other hearing participants.

To ensure that everyone has an adequate opportunity to speak, each speaker at a public hearing will be allotted 5 minutes. Depending on the number of persons who request an opportunity to speak, more time may be allowed for speakers representing several parties or organizations. Persons wishing to speak on behalf of organizations should identify the organization in their request Written comments will also be accepted at the hearings, and speakers at public hearings are encouraged to provide written versions of their oral comment for the record.

DOE will take notes and prepare a summary f the oral comment received during the public hearings.

Schedule of Public Hearings

December 10, 1997-Roci-v Flats Environmental Technology Site, 4ear Golden, CO

6:00-9:00 pm mountain time. Rocky Flats Environmental Technology Site, Building 060 (outside of the West Gate of @he Rocky Flats Environmental Technology Site), State Highway 93, Golden, CO 8(r4o2. Contact: Michael Konczal. 303-966-7095.

December 11, 1997-tns Alamos, NM 6:00-9:00 pm mountain time, Los Alamos Area Office, 528--35th Street, Roams 100/129, Los Alamos, NM 87544. Contact.-Bob Promell, 505--665-4411.

December 16, 1997-A ugusta, Georgia 6:00-9:00 pm eastern time. Ramada Plaza Hotel, Grove Room, 640 Broad Street, Augusta, CA 30901. Contact: Drew Grainger, $07-725-1523.

Public Reading Rooms where the draft EIS is available-

U.S. Department of Energy. Freedom of Information Room, Room IF,190. Forrestal Building, 1000 Independence Avenue, SW, Washington, DC 20585. Telephone 202-585--6020.

Lawrence Livermore National Laboratory, East Gate Visitors Center, Greenville Road, Livermore, CA 94550. Telephone 5ID-424-4026.

California State University. NorOuidge/Oviatt Library, 18111 Nordhoff Street, Northridge, CA 91330. Telephone 818--677-2274.

U.S. Depart3nent of Energy, Oakland Operations Office, Public Reading Room, Energy Information Center, 8th Floor, 1301 Clay Street, Oakland. CA 94612. Telephone 510--63'7-1762.

Simi Valley Public Library, 2629 Tapa Canyon Road, Simi Valley, CA 93063. Telephone 805-525-2384.

Platt Brand Public Librwy, 23600 Victory Boulevard. Woodland I-lills, CA 91367. Telephone 818--887-0160.

Standley Lake Public Reading Room, 8485 Kipling Street, Arvada, CO 80005. Telephone 303-456-0806.

University of Colorado Libraries, Government Publications, Campus Box 184. Boulder. CO 80309. Telephone 303-492-1411.

U.S. EPA Superfund Records Center. 999 18th Street. 5th Floor Denver, CO 80202. Telephone 303-312-6473.

Colorado Department of Public Health and Environment, Information Center, 4300 Cherry Creek Drive South. Denver, CO 80222. Telephone 303--692-2037.

Colorado State University, Document Department, The Libraries, Fort Collins, CO 80523. Telephone 970-491-1101.

U.S. Department of Energy. Golden Field Office, Public Reading Room,

14869 Denver West Parkway. Golden, CO 80401. Telephone 303-275-4742. Colorado School of Mines, Arthur Lakes Library, 1400 Illinois Street. Golden, CO ao4oi. Telephone 303-273- 3000.

Rocky Flats Citizens Advisory Board, Public Reading Room, 9035 Wadsworth Avenue, Suite 2250, Westminster, CO 80021. Telephone 303-420--7855.

Rocky Flats Public Reading Room, Front Range Community College Library, 3645 West 112th Avenue, Westininster, CO 80030. Telephone 303-459-4435.

Pullen Public Library. 100 Decatur Street, SE, Atlanta, GA 30303. Telephone 40"51-2185.

Georgia Institute of Technology, Bobby Dodd Way, Atlanta. GA 30332. Telephone 404--894-4519.

Reese Ubrary-Augusta College, 2500 Walton Way, Augusta, GA 30904. Telephone 706-737-1744.

Chatham Effingham Library. 2002 Bull Street, Savannah, GA 314la9. Telephone 912-234-5127.

Argonne National Laboratory, Technical Library, P.O. Box 2528, Idaho Falls, ID 83403. Telephone 208-533- 7341.

University of Illinois at Chicago, U.S. Department of Energy, Public Document Room, 3rd Floor, 801 S. Morgan Street, Chicago, EL 60607. Telephone 312-996- 2738.

East St. Louis Public Library, 405 North 9& Street, East St. Louis, IL 62201. Telephone 618-747-7260.

Lincoln Public Library. 326 South 7th Street, Springfield, IL 62701. Telephone 217-753-4900.

Salina Public Library, 301 West Elm. Salina, KS 67401. Telephone 785--825- 4524.

Washburn Law Library, 1700 College, Topeka. KS 66621. Telephone 913-231- 1010.

U.S. Department of Energy, Environmental Information Center, 175 Freedom Boulevard, Kevil, KY 42053. Telephone 502-462-2550.

Paducah Public Library, 555 Washington Street, Paducah, KY 42001. Telephone 502-442-2510.

Mid Continent Public Library, Blue Ridge Branch, 9253 Blue Ridge Boulevard, Kansas City, MO 64138. Telephone 816-761-3382.

St. Louis Public Library, 1301 Olive Street, St. Louis, MO 63103. Telephone 314-241-2288.

Scenic Regional Library, 308 Hawthorn Drive, Union. MO 63084. Telephone 314-583-3224.

Albuquerque Operations Office, National Atomic Museum, 20358 Wyoming Boulevard SE, Kirtland Air Force Base, Albuquerque, KM 67185. Telephone 505-845-4378.

U.S. Department of Energy, Technical Vocation Institute, Main Campus Library, 525 Buena Vista SE, Albuquerque, KM 87106. Telephone 505-845-4378.

U.S. Department of Energy, FOIA Reading Room, 4700 Morris NE, Albuquerque. KM 6711 1. Telephone 505-224-5731.

Los Almost Community Reading Room. 1350 Central, Suite 101, Los Almost, NM 67544. Telephone 505- 665-2127.

New Mexico State Library, 325 Don Gaper, Santa Fe, NM 87503. Telephone 505--827-3800.

U.S. Department of Energy. Public Reading Room, Gregg Graniteville Library, 171 University Parkway. Aiken, SC 29801. Telephone 803--641-3465.

County Library, 404 King Street, Charleston, SC 29403. Telephone 803- 723-1645.

South Carolina State Library, 1500 Senate Street, Columbia, SC 29211. Telephone 803-734-8666.

Orangeburg County Free Library. 510 Louis Street, NE, Orangeburg, SC 291 IS. Telephone 803-531-4636.

Lawson.McGhee Public Library, 500 West Church Avenue, Knoxville, TN 37902. Telephone 615-544-5750.

Nashville Public Library, 225 Polk Avenue, Nashville, TN 37203. Telephone 615-862-5800.

U.S. Department of Energy, Public Reading Room, Oak Ridge Operations Office, 55 Jefferson Circle, Room 1123, Oak Ridge, TN 37831. Telephone 615- 576-1216.

Issued in Washington, D.C., November 20. 1997.

David G. Huzienga,

ActinSDeputyAssistant SecretaryforNuclea@ Material and Facility Stabilization, Office of Environmental Management.

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Appendix A

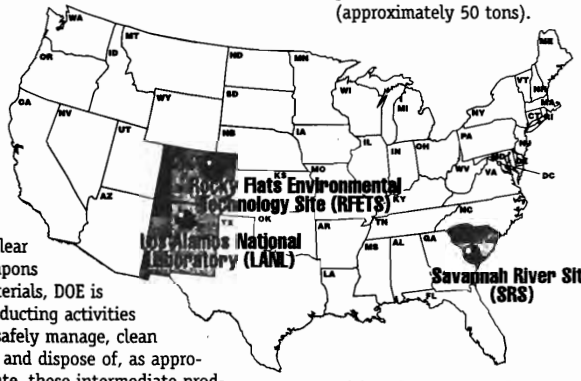
Factsheet

The National Environmental Policy Act of 1969 (NEPA) requires the preparation of an Environmental Impact Statement (EIS) for major Federal actions that may significantly affect the quality of the environment. An Environmental Impact Statement looks at both the short-term and long-term effects of the proposed actions.

The Department of Energy has prepared a *Draft Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site*. This document analyzes alternatives for processing these plutonium bearing materials to address health and safety issues raised by the Defense Nuclear Facilities Safety Board, and to prepare the materials for disposal or other disposition. Some alternatives would involve transporting some of the plutonium residues and scrub alloy to the Savannah River Site in South Carolina and/or to the Los Alamos National Laboratory in New Mexico during the 1998-2004 timeframe.

Background

During the Cold War era, the Department of Energy (DOE) and its predecessor agencies produced materials for use in nuclear weapons. During these manufacturing and production activities, several intermediate products were generated, some of which remain in storage at various DOE sites. Now that the Cold War is over and the United States has ceased production of nuclear weapons materials, DOE is conducting activities to safely manage, clean up, and dispose of, as appropriate, these intermediate products and byproducts.



Sites where certain Rocky Flats plutonium residues and scrub alloy could be processed

Among the intermediate products requiring proper management and preparation for disposal or other disposition are the plutonium residues and scrub alloy currently stored at the Rocky Flats Environmental Technology Site (Rocky Flats), located near Golden, Colorado. Approximately 42,200 kilograms (kg) of plutonium residues (containing 2,600 kg of plutonium) and 700 kg of scrub alloy (containing 200 kg of plutonium) require processing prior to disposal as transuranic waste at the Waste Isolation Pilot Plant, located in Carlsbad, New Mexico, or other disposition to address health and safety issues raised by the Defense Nuclear Facilities Safety Board in their Recommendation 94-1. This is equivalent to about 95,000 pounds of plutonium residues and scrub alloy (approximately 50 tons).

Although these stored materials are not directly usable in nuclear weapons, they remain a potential target for theft as a source of plutonium for use in nuclear weapons or other devices. Processing is also required to convert these materials into a form that is suitable for disposal or other disposition.

Management Alternatives Analyzed in the Draft EIS

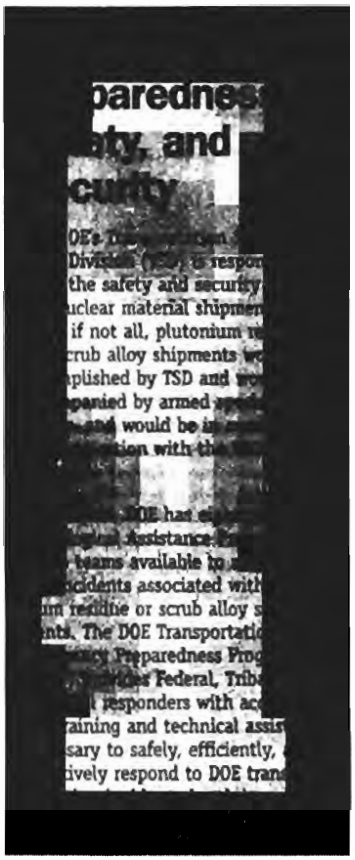
The processing alternatives evaluated for the various types of plutonium residues and the scrub alloy include:

- **No action**—*continue current stabilization activities at Rocky Flats for continued onsite storage. However, the residues and scrub alloy may be left in a form that is unsuitable for disposal or other disposition.*
- **Processing without separating the plutonium from the residues and scrub alloy**—*includes immobilization and dilution technologies, with all processing taking place at Rocky Flats. The materials would then be suitable for disposal at the Waste Isolation Pilot Plant.*
- **Processing with separation of the plutonium from the residues and scrub alloy**—*includes various plutonium separation techniques. Onsite processing is evaluated at Rocky Flats for most of the residues and scrub alloy; offsite processing is evaluated at the Savannah River Site and at Los Alamos National Laboratory for certain types of*

(Alternatives continued on page 2)

Alternatives
(continued from page 1)

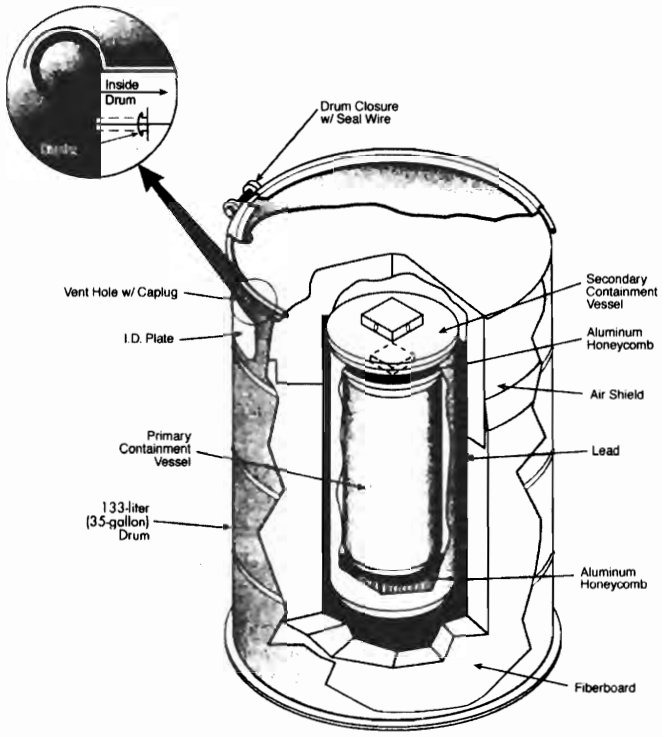
residues and the scrub alloy. Any plutonium separated from residues and scrub alloy would be stored pending disposition in compliance with decisions to be made after completion of the Surplus Plutonium Disposition Environmental Impact Statement described in a Notice of Intent issued in the Federal Register on May 22, 1997 (62 FR 28009). During storage, any separated plutonium would be protected through use of the same safeguards and security measures being used to protect the much larger amount of plutonium already in DOE's inventory. In accordance with existing DOE policy, any plutonium separated under this EIS would not be used in nuclear weapons.



Containment and Shipment of Plutonium Residues and Scrub Alloy

The alternatives evaluated in the EIS include possible shipments from Rocky Flats to the Savannah River Site and/or the Los Alamos National Laboratory from approximately 1998 to 2004. Offsite shipments of plutonium residues and scrub alloy would be made using "Type B" containers, which are authorized by DOE and used in accordance with Department of Transportation regulations. Type B containers have been designed to minimize the possibility of dispersal, radiation, and criticality, and are tested under normal and accident conditions.

Prior to shipment, preprocessing and repackaging will occur at Rocky Flats. Under all of the alternatives evaluated in the Draft EIS, the maximum number of shipments to the Savannah River Site between 1998-2004 would be 208. The maximum number of shipments to the Los Alamos National Laboratory would be 62 during the 1998-2004 timeframe. Under the "preferred alternative" identified in the Draft EIS, the number of shipments would be significantly lower (up to 39 highway shipments could be made to the Savannah River Site, and up to 13 highway shipments could be made to the Los Alamos National Laboratory during the 1998-2004 timeframe).



A typical Type B container for shipments of plutonium residues and scrub alloy

Characteristics of Plutonium Residues and Scrub Alloy

Plutonium residues and scrub alloy are "plutonium-bearing" materials. Plutonium residues are primarily in the form of salts, ash, sludge, and contamination on rags, glass, and metal pieces. Scrub alloy is a metal mixture created as an interim step in plutonium recovery, and is primarily composed of magnesium, aluminum, americium, and plutonium.

Plutonium is a solid, heavy metal that is not readily dispersed in the air. It is not very water soluble or highly chemically reactive. Plutonium's physical characteristics allow for little absorption into the human body through ingestion or skin exposure. The most significant potential exposure is by inhalation of plutonium compounds. Once inhaled, plutonium particles stick to the lung tissue. Then the alpha radiation from the plutonium can cause lung cancer.

The overall human health risk to the public from plutonium during transportation is very low. The preprocessing/repackaging safeguards undertaken prior to shipment and the multiple layers of containment provided by containers severely limit the potential for inhalation.

Packaged residues

Residues from processing

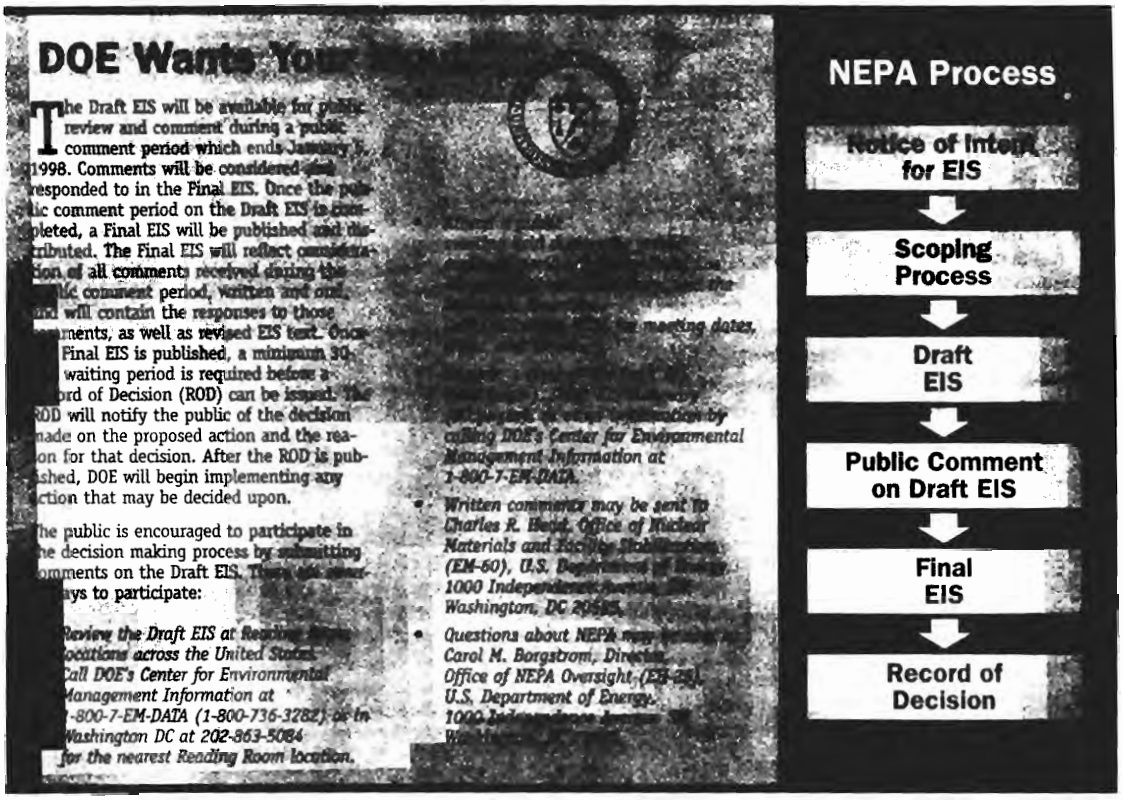
Drums in storage

Safe Transport [illegible]

DOE has safely transported radioactive [illegible] over 40 years. Over the past 25 years, [illegible] mately 70 shipments of plutonium resi[illegible] scrub alloy have been safely transported from [illegible] to the Savannah River Site [illegible] using the [illegible] [illegible]ly used to [illegible] [illegible] components.

The Safe Secure Trailer System [illegible] designed, 18-wheel tractor-trailer [illegible] [illegible] deterrents to prevent unauthorized removal [illegible] cargo. The Trailer [illegible] has enhanced [illegible] transit safety [illegible] standards si[illegible] applied to simila[illegible] employs special[illegible] conducts periodic [illegible] ing transport operati[illegible] approved procedures.

Safe Secure Trailer System



If you are interested in receiving the Draft EIS (available now) or the Final EIS when it is issued, please fill out the form below.

☐ Draft Summary Only
(one volume, approximately 80 pages)

☐ Draft Full EIS
(three volumes, approximately 900 pages)

☐ Final Summary Only

☐ Final Full EIS

☐ Record of Decision
(one volume, approximately 50 pages)

NAME:

ORGANIZATION:

ADDRESS:

CITY: STATE: ZIP:

Please fax this form to:
Charles R. Head
202-586-5393

Mail to:
Charles R. Head
U.S. Department of Energy, EM-60
1000 Independence Avenue, SW
Washington, DC 20585

For more information:
Center for Environmental Management Information
1-800-7-EM-DATA (1-800-736-3282) or in Washington DC at 202-863-5084

Appendix A

Public Reading Rooms

PUBLIC READING ROOMS

A complete copy of the Final EIS may be reviewed at any of the Public Reading Rooms and Libraries Listed below.

Simi Valley Public Library
2629 Tapo Canyon Road
Simi Valley, CA 93063

Lawrence Livermore National Laboratory
East Gate Visitors Center
Greenville Road
Livermore, CA 94550

CSU Northridge/Oviatt Library
18111 Nordhoff Street
Northridge, CA 91330

U.S. Department of Energy
Oakland Operations Office
1301 Clay Street
Room EIC, 8th Floor
Oakland, CA 94612

Platt Brand Public Library
23600 Victory Boulevard
Woodland Hills, CA 91367

U.S. Department of Energy
Golden Field Office
Public Reading Room
14869 Denver West Parkway
Golden, CO 80401

U.S. EPA
Superfund Records Center
999 18th Street, Floor 5
Denver, CO 80202

Rocky Flats Citizens Advisory Board
Public Reading Room
9035 Wadsworth Avenue, Ste. 2250
Westminster, CO 80021

Standley Lake Public Reading Room
8485 Kipling Street
Arvada, CO 80005

Rocky Flats Public Reading Room
Front Range Community College Library
3645 W. 112th Avenue
Westminster, CO 80030

University of Colorado Libraries
Government Publications
Campus Box 184
Boulder, CO 80309

Colorado Department of Public Health
4300 Cherry Creek Drive South
Denver, CO 80222

Colorado State University
Document Department
The Libraries
Fort Collins, CO 80523

Colorado School of Mines
Arthur Lakes Library
1400 Illinois Street
P.O. Box 4029
Golden, CO 80401

Colorado State University
Library Documents Department
Ft. Collins, CO 80523

U.S. Department of Energy
1000 Independence Avenue SW
FOI Room, 1E-190, Forrestal Bldg.
Washington, DC 20585

Pullen Public Library
100 Decatur Street SE
Atlanta, GA 30303

Chatham Effingham Library
2002 Bull Street
Savannah, GA 31499

Reese Library
Augusta College
2500 Walton Way
Augusta, GA 30904

Georgia Institute of Technology
Bobby Dodd Way
Atlanta, GA 30332

Argonne National Laboratory
Technical Library
P.O. Box 2528
Idaho Falls, ID 83403

University of Illinois at Chicago
U.S. DOE Public Documents Room
801 S. Morgan Street, 3rd Floor
Chicago, IL 60607

East St. Louis Public Library
Dr. Ram Chauhan
405 North 9th Street
East St. Louis, IL 62201

Lincoln Library
Reference Department
326 South 7th Street
Springfield, IL 62701

Salina Public Library
Marc Boucher, Reference Librarian
301 West Elm
Salina, KS 67401

Washburn Law Library
1700 College
Topeka, KS 66621

Paducah Public Library
555 Washington Street
Paducah, KY 42001

U.S. DOE
Environmental Information Center
175 Freedom Boulevard
Kevil, KY 42053

Mid Continent Public Library
Blue Ridge Branch
9253 Blue Ridge Boulevard
Kansas City, MO 64138

St. Louis Public Library
1301 Olive Street
St. Louis, MO 63103
Scenic Regional Library
308 Hawthorn Drive
Union, MO 63084

Los Alamos Community Reading Room
1350 Central Avenue, Suite 101
Los Alamos, NM 87544

U.S. DOE Albuquerque Operations Office
National Atomic Museum
20358 Wyoming Boulevard SE
Kirtland Air Force Base
P.O. Box 5400
Albuquerque, NM 87185

U.S. Department of Energy
FOIA Reading Room
4700 Morris NE
Albuquerque, NM 87111

U.S. Department of Energy
Technical Vocational Institute
Main Campus Library
525 Buena Vista SE
Albuquerque, NM 87106

New Mexico State Library
325 Don Gasper
Santa Fe, NM 87503

U.S. Department of Energy
Gregg Graniteville Library
171 University Parkway
Aiken, SC 29801

County Library
404 King Street
Charleston, SC 29403

South Carolina State Library
1500 Senate Street
P.O. Box 11469

Orangeburg County Free Library
510 Louis Street NE
P.O. Box 1367
Orangeburg, SC 29116

Lawson McGhee Public Library
500 West Church Avenue
Knoxville, TN 37902

Nashville Public Library
225 Polk Avenue
Nashville, TN 37203

DOE Public Reading Room
Oak Ridge Operations Office
55 Jefferson Circle, Room 1123
Oak Ridge, TN 37831

Appendix A

Contractor Disclosure Statement

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF EIS ON MANAGEMENT OF CERTAIN PLUTONIUM RESIDUES AND SCRUB ALLOYS STORED AT ROCKY FLATS

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project "for the purposes of this disclosure is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project "includes" any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." 46 FR 18026-18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) to assure consideration of your proposal).

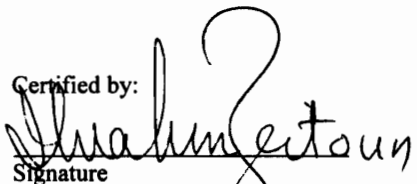
(a) __✓__ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) _____ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.
2.
3.

Certified by:



Signature

Ibrahim H. Zeitoun
Name

Project Manager and Vice President

April 17, 1997
Date

Science Applications International Corporation

APPENDIX B
PLUTONIUM RESIDUES AND SCRUB ALLOY CHARACTERISTICS

B.1 SUMMARY

The Rocky Flats Environmental Technology Site (Rocky Flats) currently stores 106,600 kilograms (kg) (235,000 pounds [lb]) of residues and 700 kg (1,540 lb) of scrub alloy containing approximately 3,000 and 200 kg (6,600 and 440 lb) of plutonium, respectively. The plutonium residues were analyzed in the *Environmental Assessment, Finding of No Significant Impact, and Response to Comments—Solid Residue Treatment, Repackaging, and Storage* (DOE 1996e), referred to herein as the "Solid Residue Environmental Assessment." Approximately 40 percent of the residues discussed in the Solid Residue Environmental Assessment contain plutonium in concentrations that meet neither the Safeguards Termination Limits established by the U.S. Department of Energy (DOE) Office of Safeguards and Security in 1996 nor the criteria for long-term storage as oxide or metal in accordance with DOE-STD-3013-96, *DOE Standard: Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage* (DOE 1996b). The Safeguards Termination Limits are plutonium concentration limits imposed on special nuclear material that cannot be exceeded if material accountability requirements are to be terminated, as would be required if the residues were to be shipped to the Waste Isolation Pilot Plant (WIPP). As a result, the plutonium residues require further processing to meet criteria for disposal or other disposition.[1] The Rocky Flats scrub alloy is a DOE Defense Programs material and is not considered a waste material. Scrub alloy is included in this Environmental Impact Statement (EIS) to provide National Environmental Policy Act (NEPA) documentation for its stabilization.

This appendix describes all residues and scrub alloy at Rocky Flats, including the total inventory of the residues that would remain above the Safeguards Termination Limits after being processed by the methods described in the Solid Residue Environmental Assessment. Material categories are identified and processing of the materials according to the Rocky Flats baseline plans (DOE 1996c) is discussed. Processes used for the generation of each of the specific materials, identification of the buildings in which the generation occurred, material descriptions, packaging and configurations, and material compositions are also included.

The Rocky Flats materials were grouped into five categories in the *Notice of Intent to Prepare an Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (DOE 1996a) based on similarities in potential processing alternatives. The five categories include four residue categories (ash, salt, wet, and direct repackage) and one scrub alloy category. The four residue categories are divided into subcategories, which are further divided into the Item Description Codes (IDCs) used by Rocky Flats to categorize its residues. IDCs were developed in the late 1970s and early 1980s as a means to determine which nondestructive assay standard to use. There are approximately 100 IDCs in use at Rocky Flats. The total quantity of bulk material and plutonium (in kilograms [pounds)], the quantity of plutonium that would require processing to meet the Safeguards Termination Limits (in kilograms [pounds]), the bulk containing that plutonium (in kilograms [pounds]), and the Safeguards Termination Limit for the material (in weight percent) are itemized by IDC in tables throughout this appendix. The five Rocky Flats material categories from the Notice of Intent are described in the following paragraphs:

[1] *Some of the plutonium residues have been or are being proposed to be dispositioned through the Safeguards Termination Limit variance (or waiver) process.*

- **Ash Residues—**Residues in this category were generated during production, research and development, strip-out, and maintenance operations and contain approximately 27,900 kg (61,500 lb) of total residue material, including approximately 1,250 kg (2,760 lb) of plutonium. Approximately 72 percent of the total residue material requires additional processing to meet the Safeguards Termination Limits. The subcategories include incinerator ash residues; inorganic residues; sand, slag, and crucible residues; and graphite fines residues.

- **Salt Residues—**Residues in this category were generated in pyrochemical operations and contain approximately 16,000 kg (35,300 lb) of total residue material, including approximately 1,000 kg (2,200 lb) of plutonium. Approximately 93 percent of the total residue material requires additional processing to meet the Safeguards Termination Limits. The subcategories include electrorefining salt residues, molten salt extraction salt residues, and direct oxide reduction salt residues.

- **Wet Residues—**Residues in this category generally resulted from contact with solutions in the normal course of processing, inventory, and cleanout operations and contain approximately 16,500 kg (36,400 lb) of total residue material, including approximately 340 kg (750 lb) of plutonium. Approximately 26 percent of the total residue material requires additional processing to meet the Safeguards Termination Limits. The subcategories include wet combustible residues, plutonium fluoride residues, Raschig ring residues, sludge residues, and greases/oily sludge residues.

- **Direct Repackage Residues—**Residues in this category resulted from processing, plutonium foundry, maintenance, construction, and inventory operations and contain approximately 39,300 kg (86,600 lb) of total residue material, including approximately 340 kg (750 lb) of plutonium. Approximately 7 percent of the total residue material requires additional processing to meet the Safeguards Termination Limits. The subcategories include dry combustible residues, glass residues, miscellaneous residues, and graphite and firebrick residues.

- **Scrub Alloy—**Materials in this category resulted from the salt scrub process of molten salt extraction salts and the anode alloy processing of electrorefining anode heels; they contain approximately 700 kg (1,540 lb) of total material, including approximately 200 kg (440 lb) of plutonium. All of the scrub alloy material (100 percent) requires processing. The scrub alloy material includes magnesium/aluminum alloy that was processed at the Savannah River Site and alloy that contains calcium, which was not processed at the Savannah River Site.

B.2 ROCKY FLATS RESIDUE GENERATION

B.2.1 Introduction

See Attachment 1

Attachment 1 contains the figures for this appendix in the form of flow diagrams that show how each residue category and subcategory was produced. The IDCs for each of the subcategories are also provided.

The plutonium residues at Rocky Flats were produced during plutonium recovery and purification, manufacturing operations, or subsequent processing from 1953 to 1990. As a result of the processes used to recover and purify plutonium and to manufacture components, a variety of materials became contaminated with plutonium. If the level of contamination was low, the material was considered either transuranic or low-level waste and was disposed of at offsite burial locations. If the concentration of plutonium in the material exceeded an "economic discard limit,"[2] however,

[2]*Economic Discard Limit—The threshold for determining whether a material was waste or residue based on the economics of recovery. If the cost of recovery of the plutonium was less than the cost of new plutonium, the*

(continued...)

the material was classified as residue rather than waste and was stored for later recovery of the contained plutonium. Although large quantities of residues were processed during the operation of Rocky Flats, other residues, primarily those more difficult to process, accumulated at the site in storage.

The processes at Rocky Flats generated widely varied and complex residues. For example, some pyrochemical salts used in the purification process have residual plutonium and americium dispersed throughout a spent salt matrix. Other residue materials were generated primarily because of incidental contamination—mainly surface-contaminated materials, such as metals, molds and crucibles, paper, plastics, filters (air and liquids), and refractory materials (firebrick) from the incinerators. Another broad category of residues resulted from intermediate recovery treatment steps or ancillary treatment systems; these residues include ash generated from the volume reduction of combustibles (e.g., plastic, paper, and rags) via an incineration process, soot produced from incinerator cleanout activities, plutonium fluoride mixtures generated in hydrofluorination and reduction operations, and heels and sludges produced by aqueous treatments of various hard-to-dissolve materials (e.g., ash, soot, crucibles). Emissions treatment systems also produced several additional types of sludges, such as off-gas scrubber systems and filters from liquid filtration systems.

In addition to being contaminated with plutonium, some residues may contain co-contaminants that are subject to the Resource Conservation and Recovery Act (EPA 1976) and the Colorado Hazardous Waste Act (CDPHE 1984a) and that are regulated by the U.S. Environmental Protection Agency (EPA) or the State of Colorado. In 1991, a DOE review of backlogged residues was accomplished based on 40 Code of Federal Regulations (CFR) Part 261, Identification and Listing of Hazardous Waste. This review was delivered to the Colorado Department of Health and the Environment and was accepted as the Mixed Residue Reduction Report (DOE 1992). Since this initial review, there have been periodic reviews of the nature and status of the residue hazardous waste compliance baseline, which have been incorporated in the backlog waste reassessment process (RMRS 1996). The basis of the original determination was re-evaluated and the amount of residues regulated by the Resource Conservation and Recovery Act was reduced from 90 percent to approximately 48 percent by bulk weight.

Since the Colorado Department of Public Health and Environment has jurisdiction over hazardous and mixed waste management in Colorado, all hazardous waste regulations referenced by Rocky Flats are Colorado regulations. Some of the Rocky Flats residues have both characteristic and listed EPA hazardous waste codes as established by the Colorado Code of Regulations (CDPHE 1984b). This information is provided in Section B.3. A description of the characteristics associated with the EPA hazardous waste codes can be found in Section 261.22-24 of 6 Colorado Code of Regulations 1007-3 (CDPHE 1984b).

B.2.2 Programmatic History

The essential goal for DOE remains the safe storage of the mixed residues, residues, and scrub alloy until their ultimate processing and final offsite disposition. In 1992, Rocky Flats initiated the Residue Elimination Project to address the treatment and elimination of its stored residues. Safe storage of these materials has been evaluated by DOE and by the Defense Nuclear Facilities Safety Board (the "Board"). Once the Board makes a recommendation, the Secretary of Energy establishes an approval process and develops an implementation plan. When the plan is approved, the Board publishes the recommendation in the *Federal Register*. Currently, Board Recommendation 94-1 (DNFSB 1994b) and Board Recommendation 94-3 (DNFSB 1994a) relate to the safe storage and management of residues and scrub alloy.

(...continued)
material was considered a residue and retained for recovery; otherwise, it was declared a waste to be disposed of.

The Residue Elimination Project focused primarily on eliminating the residues by simply repackaging them, with minimal treatment, to meet the *Waste Isolation Pilot Plant Waste Acceptance Criteria* (DOE 1981). On May 26, 1994, the Board approved and issued Recommendation 94-1, which, in general, raised safety-related concerns about continued storage and about the potential management of residues and in-process materials.

In addition to the safe management of these materials, the Board was concerned with the results of the abrupt halt of nuclear weapons production and DOE's efforts to remediate its facilities. The Board concluded that immediate hazards could arise unless certain problems were corrected throughout the DOE complex. These problems related to liquids and solids containing fissile materials and other radioactive substances in spent fuel storage pools, reactor basins, reprocessing canyons, processing lines, and various buildings once used for processing and weapons manufacture. The Board addressed its concerns in Recommendation 94-1 and proposed an accelerated schedule to convert these materials to forms more suitable for safe interim storage.

Notwithstanding its acknowledgment of DOE's vulnerability assessment efforts and the NEPA documentation related to these situations, the Board made the following recommendations regarding the Rocky Flats residues and scrub alloy:

- That an integrated plan be formulated to convert plutonium-bearing materials for safe interim storage within 2 to 3 years.

- That the plan should include ways to store all plutonium metals and oxides in conformance with DOE-STD-3013-94, *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE 1994a), which was superseded by DOE-STD-3013-96, *DOE Standard: Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage* (DOE 1996b).

- That preparations be expedited to repackage plutonium metal in contact with plastic to eliminate the generation of hydrogen gas.

- That preparations be accelerated to process containers of possibly unstable residues from past plutonium operations and change the plutonium into a form suitable for safe interim storage.

To respond to Board Recommendation 94-1, Rocky Flats developed the Site Integrated Stabilization Management Plan (DOE 1996c), which describes the program and schedules to stabilize and package the residues to meet a 50-year storage standard. This plan is the governing document for the management of the Rocky Flats residues and scrub alloy, although Consent No. 93-04-23-01 (State of Colorado 1993) imposes additional requirements on the portion of residues mixed with hazardous constituents. The plan incorporates Board Recommendation 94-1 Implementation Plan milestones, which Rocky Flats routinely updates.

In April 1996, DOE's Rocky Flats Field Office issued the *Environmental Assessment, Finding of No Significant Impact, and Response to Comments—Solid Residue Treatment, Repackaging, and Storage* (DOE 1996e). The information and analyses in the "Environmental Assessment" section evaluate the impacts associated with implementation of the Site Integrated Stabilization Management Plan. The "Finding of No Significant Impact" section determines that this evaluation supports the conclusion that the proposed action would not constitute a major Federal action significantly affecting the quality of the human environment. This determination allows Rocky Flats to begin preparation to process and repackage possibly unstable residues and to store them for interim safe storage until their disposition is decided.

B.2.3 Safeguards Termination Limits, Item Description Codes, and Site Integrated Stabilization Management Plan Groups

See Attachment 1

Attachment 1 contains the figures for this appendix in the form of flow diagrams that show how each residue category and subcategory was produced. The IDCs for each of the subcategories are also provided.

On July 22, 1996, the DOE Office of Safeguards and Security issued guidance (DOE 1996d) concerning plutonium enrichment of special nuclear material that can be categorized as "attractiveness level E" for the purposes of determining levels of safeguards protection. This guidance complements existing requirements given in DOE Order 5633.3B (DOE 1994b). **Table B–1** provides a summary of the Safeguards Termination Limits established by the DOE Office of Safeguards and Security for this special nuclear material. Implementation of this new guidance indicates that approximately 40 percent of the materials to be processed as described in the Site Integrated Stabilization Management Plan would not meet the new guidance requirements.

Table B–1 Safeguards Termination Limits Attractiveness Level E Criteria for Special Nuclear Material

Category	*Description/Form*	*Threshold (Weight %)*	
		A [a]	*B* [b]
Readily Recoverable	Special nuclear material solutions and oxides: nitrate, caustic, chloride solutions, contaminated/impure oxides, metal fines and turnings, glovebox sweepings	0.1	N/A
Recoverable	Special nuclear material amenable to dissolution and subsequent separation: pyrochemical salts; chloride melt; hydroxide cake; floor sweepings; alumina; condensates; reduction residues; sand, slag, and crucible; magnesium oxide crucible	0.1	0.2
Difficult to Recover	Special nuclear material in organic matrices or requiring pyrochemical separation disassembly and subsequent multiple recovery operations: high-efficiency particulate air filters, organic solutions, oils and sludges, graphite or carbon scrap; surface contaminated plastics, metal components, combustible rubber	0.2	1.0
Extremely Difficult to Recover	Special nuclear material bound in matrix of solid sintered or agglomerated refractory materials: special nuclear material embedded in glass or plastic, high fired incinerator ash, special resins, salt sludges, raffinates and sulfides	0.5	2.0
Practically Unrecoverable	Special nuclear material microencapsulated in refractory compounds or in solid dilution: vitrified, bituminized, cemented, or polymer-encapsulated materials; special nuclear material alloyed with refractory elements (tungsten, palladium, chromium, stainless steel), ceramic/glass salvage	1.0	5.0

N/A = Not applicable

[a] Threshold A: Maximum special nuclear material concentration upon which Materials, Controls, and Accountability and physical protection can be terminated if conditions in DOE Order 5633.3B, 1, 1, 1 are met.

[b] Threshold B: Maximum special nuclear material concentrations upon which only physical protection measures equivalent to category IV requirements can be applied if conditions in DOE Order 5633.3B 1, 1, 1 are met. The various categories (I through IV) relate to the amount of fissile material contained in various nuclear materials and are discussed in detail in DOE Order 5633.3B.

Table B–2, "Residue IDCs Comparison Between the Solid Residue Environmental Assessment and the Site Integrated Stabilization Management Plan Information," tracks Item Description Codes (IDCs) by the various residue management mechanisms that have been used over the past several years. The table provides a method for cross-correlating individual IDCs using the Solid Residue Environmental Assessment residue categories and the Site Integrated Stabilization Management Plan (DOE 1996c) group categorizations. Table B–2 also shows selected safety concerns and the current baseline Site Integrated Stabilization Management Plan processing methods being pursued by Rocky Flats for each IDC.

Table B–2 Residue IDCs Comparison Between the Solid Residue Environmental Assessment and the Site Integrated Stabilization Management Plan Information

Environmental Assessment Category	*IDC*		*Site Integrated Stabilization Management Plan*			
	Number	*Description*	*Residue Type*	*Group #* [a]	*Safety Concern* [b]	*Treatment* [c]
Ash Residues	310	Graphite Fines	Ash	4	3	3
	333	Calcium	Salt	3	2	2
	368	Magnesium Oxide Crucible	Ash	11	N/A	9
	372 [d]	Grit	Ash	11	N/A	9
	373 [d]	Firebrick Heel	Wet/Misc	11	N/A	9
	378	Firebrick, Fines	Ash	11	N/A	9
	387	Reburned Sand, Slag, and Crucible Sweepings	Ash	4	3	3
	390	Unpulverized Slag	Ash	4	3	3
	391	Unpulverized Sand and Crucible	Ash	4	3	3
	392	Unpulverized Sand, Slag, and Crucible	Ash	4	3	3
	393	Sand, Slag, and Crucible Heel	Ash	4	3	3
	394	Sand from Button Breakout	Ash	4	3	3
	395	Unpulverized Slag and Crucible	Ash	4	3	3
	396	Pulverized Slag	Ash	4	3	3
	398	Pulverized Sand, Slag, and Crucible	Ash	4	3	3
	419	Unpulverized Incinerator Ash	Ash	9	N/A	8
	420	Pulverized Incinerator Ash	Ash	9	N/A	8
	421	Ash Heel	Ash	9	N/A	8
	422	Soot	Ash	9	N/A	8
	423 [d]	Soot Heels	Ash	9	N/A	8
	428	Incinerator Ash for Materials Management	Ash	9	N/A	8
	H61	Oxide from Ducts	Wet/Misc	11	N/A	9
Salt Residues	044	Americium and Miscellaneous Oxide	Salt	2	2	2
N/E	363	Electrorefining Salt - 1st Run	Salt	1	2	2
N/E	364	Electrorefining Salt - 2nd Run	Salt	1	2	2
	365	Salt from Bad Direct Oxide Reduction	Salt	3	2	2
	404	Molten Salt Calcium, Zinc, Potassium	Salt	3	2	2
	405	Molten Salt Extraction Salt	Salt	2	2	2
	406	Molten Salt Extraction Salt	Salt	2	2	2
	407	Molten Salt Extraction Salt	Salt	2	2	2
	408	Molten Salt Extraction Salt	Salt	2	2	2
	409	Molten Salt Extraction Salt	Salt	2	2	2
	410	Molten Salt Extraction Salt	Salt	2	2	2
	411	Electrorefining Salt	Salt	1	2	2
	412	Gibson Salt	Salt	3	2	2
	413	Impure Salt/Cleanout	Salt	3	2	2
	414	Direct Oxide Reduction Salt with Calcium	Salt	3	2	2
	415	Plutonium Chloride Mixed Salt	Salt	3	2	2
	416	Zinc/Magnesium Alloy Metal	Salt	3	2	2
	418	Molten Salt Extraction Salt for Los Alamos National Laboratory	Salt	2	2	2
N/E	426	Reburned IDC 413	Salt	3	2	2
	427	Molten Salt Extraction Dicesium Salt	Salt	3	2	2
	429	Scrub Alloy Salt	Salt	1	2	2
	433	Spent Dicesium Salt	Salt	3	2	2
	434	Salt with Free Calcium	Salt	3	2	2
N/E	435	Spent Cerium/Calcium Salt Scrub	Salt	3	2	2
	473	Electrorefining Salt for Los Alamos National Laboratory	Salt	1	2	2
	601	Aluminum/Magnesium Oxide	Salt	11	N/A	9
	654	Electrorefining Salt from Plutonium/Neptunium	Salt	1	2	2
	655	Electrorefining Ceramics from Plutonium/ Neptunium	Ash	11	N/A	9

Environmental Assessment Category	*IDC*		*Site Integrated Stabilization Management Plan*			
	Number	*Description*	*Residue Type*	*Group # [a]*	*Safety Concern [b]*	*Treatment [c]*
Wet Residues	089	Grease Oxide	Combustible	7	6	6
	090	Plutonium Fluoride	Wet Misc	8	7	7
	091	Non-Specification Plutonium Fluoride	Wet Misc	8	7	7
	092	Plutonium Fluoride Heel	Wet Misc	8	7	7
	093	Sodium Fluoride Pellets	Wet Misc	8	7	7
	097	Impure Plutonium Fluoride	Wet Misc	8	7	7
	099	Grease Fluoride	Combustible	7	6	6
	290	Filter Sludge	Wet Misc	12	8	10
	291	Lab Fluoride Sludge	Wet Misc	12	8	10
	292	Incinerator Sludge	Wet Misc	12	8	10
	299	Miscellaneous Sludge	Wet Misc	12	8	10
	331	Split Ful Flo, Organic Contaminated	Combustible	6	5	5
	331	Split Ful Flo, Nitrate Contaminated	Combustible	5	4	4
	332	Oily Sludge	Combustible	7	6	6
	335	Drybox Filters/Not Acid Contaminated	Wet Misc	5	4	4
	336	Split Wet Combust, Organic Contaminated	Combustible	6	5	5
	336	Split Wet Combust, Nitrate Contaminated	Combustible	5	4	4
	338	HEPA Filter Media	Combustible	5	4	4
	339 [d]	Leaded Gloves	Combustible	5	4	4
	340	Sludge from Size Reduction Vault	Wet Misc	12	8	10
	341	Leaded Gloves/Acid Contaminated	Combustible	5	4	4
	342	Drybox Filters/Acid Contaminated	Combustible	5	4	4
	376	Processed HEPA Filter Media	Combustible	5	4	4
	441	Unleached Raschig Rings	Inorganic	13	N/A	11
	490	HEPA Filters Non-Acid Content	Combustible	5	4	4
Direct Repackage Residues	197	Tantalum Targets	Inorganic	11	N/A	9
	300	Graphite Mold	Wet Misc	11	N/A	9
	303	Graphite Chunks	Inorganic	11	N/A	9
	312	Graphite Coarse	Inorganic	11	N/A	9
	320	Heavy Metal Non-Special Source	Wet Misc	11	N/A	9
	321 [d]	Lead	Inorganic	11	N/A	9
	330	Dry Combustibles	Combustible	10	N/A	9
	334 [d]	Fire Blanket	Inorganic	11	N/A	9
	337	Plastics	Combustible	10	N/A	9
N/E	360	Aluminum Oxide Ceramic Crucible	Inorganic	11	N/A	9
	374 [d]	Blacktop, Concrete	Ash	11	N/A	9
	370	LECO Crucible	Inorganic	11	N/A	9
	371 [d]	Firebrick	Inorganic	11	N/A	9
	377	Coarse Firebrick	Inorganic	11	N/A	9
	438	Insulation	Inorganic	11	N/A	9
	440	Glass	Inorganic	13	N/A	11
	442	Leached Raschig Rings	Inorganic	13	N/A	11
	479 [d]	Empty Reusable Cans in Drum	N/E	N/E		
	480	Light Metal	Inorganic	11	N/A	9

HEPA = high-efficiency particulate air MISC = miscellaneous N/A = not applicable N/E = No entry in the Solid Residue Environmental Assessment

[a] ***Site Integrated Stabilization Management Program Group Numbers***

1. Electrorefining and Salt Scrub Salts
2. Molten Salt Extraction Salts
3. Direct Oxide Reduction and Dicesium Hexachloroplutonate Salts
4. Sand, Slag, and Crucible and Graphite Fines
5. Nitrate-Contaminated Combustibles
6. Organic-Contaminated Combustibles
8. Fluorides
9 Ash
10. Dry Combustibles
11. Firebrick, Graphite and Inorganics
12. Sludges
13. Glass

7. Greases and Oily Sludges
14. Classified Inorganics*

[b] ***Site Integrated Stabilization Management Program Safety Concerns***

1. Oxidizer
2. Water Reactive, Shock Sensitive, Pyrophoric
3. Pyrophoric
4. Fuel/Oxidizer
5. Corrosivity
6. Gas Generation
7. Radiation Exposure
8. Free Liquid

[c] ***Site Integrated Stabilization Management Program Treatments*****

1. Cementation
2. Molten Oxidation
3. Calcination
4. Wash and Dry
5. Low Temp Thermal Desorption/Water Oxidation
6. Venting
7. Dissolution and Conversion to Oxide
8. Calcination to Meet Interim Safe Storage Criteria
9. Repack to Meet Interim Safe Storage Criteria and Waste Acceptance Criteria
10. Dried or Absorbed
11. Repack to Waste Acceptance Criteria
12. Declassified and Repacked

[d] IDCs that do not contain any material identified for further processing to meet the safeguards limits for low-grade special nuclear materials.
*This table does not include residues that have been categorized as "Classified Shapes or Classified Inorganics." These residues do not require further processing beyond that analyzed in the Solid Residues Environmental Assessment.
**These treatments were the basis for analyses in the Solid Residues Environmental Assessment and are the "no action" processes discussed in this EIS.

Not all the residue IDCs identified in Table B–2 will require further processing to meet the safeguards limits for low-grade special nuclear materials. The rest of this appendix describes those residues that may require further processing.

B.3 DETAILED DISCUSSIONS OF ROCKY FLATS RESIDUES

B.3.1 Introduction

The following sections give technical descriptions of the plutonium-bearing residues stored at Rocky Flats. In the Notice of Intent, the residues and scrub alloy buttons are divided into the five categories. To further characterize the residue material categories that were identified in the Notice of Intent, 10 material categories have been defined and are described in detail in Section 2.7 Management Alternatives—Sections 2.7.2 through 2.7.11—of this EIS, which also includes processing/technology discussions. The 10 residue material categories are as follows:

1. Ash Residues
2. Pyrochemical Salt Residues
3. Plutonium Fluoride Residues
4. Sludge Residues
5. Filter Media Residues
6. Combustible Residues
7. Glass Residues
8. Graphite Residues
9. Inorganic (Metals and Others) Residues
10. Scrub Alloy

Table B–3 shows how these 10 categories correspond to the 5 residue material categories identified in the Notice of Intent. The table includes the Notice of Intent residue material categories, the corresponding EIS material categories, and the material Item Description Codes (IDCs) associated with each.

Table B–3 Correspondence Between Notice of Intent Categories and EIS Categories

Notice of Intent Categories	*EIS Categories*	*IDCs*
Ash Residues	**Ash Residues**	
- Incinerator Ash	- Incinerator Ash	378, 419, 420, 421, 422, 428
- Sand, Slag, and Crucible	- Sand, Slag, and Crucible	333, 387, 390, 391, 392, 393, 394, 395, 396, 398
- Graphite Fines	- Graphite Fines	310
- Inorganic Ash	- Inorganic Ash	368, H61
Salt Residues	**Pyrochemical Salt Residues**	
- Electrorefining Salts	- Electrorefining Salts	411, 473, 654, 655
- Molten Salt Extraction Salts	- Molten Salt Extraction Salts	044, 405, 406, 407, 408, 409, 410, 418, 429, 601
- Direct Oxide Reduction Salts	- Direct Oxide Reduction Salts	365, 404, 412, 413, 414, 415, 416, 417, 427, 433, 434, 435
Wet Residues		
- Plutonium Fluoride	**Plutonium Fluoride Residues**	090, 091, 092, 093, 097
	Sludge Residues	
- Sludge	- Sludge	290, 291, 292, 299, 340
- Greases/Oily Sludge	- Greases/Oily Sludge	089, 099, 332
	Filter Media Residues	331, 335, 338, 342, 376, 490
- Wet Combustibles	**Combustible Residues** (Partial) - Aqueous/Organic-Contaminated Combustibles	336, 341
	Glass Residues (Partial)	
- Raschig Ring	- Raschig Ring (Unleached, Leached)	441, 442
Direct Repackage	**Glass Residues (Partial)**	
- Glass	- Other Glass	440
	Combustible Residues (Partial)	
- Dry Combustibles	- Dry Combustibles	330, 337
	Graphite Residues	
- Graphite, Firebrick	- Graphite, Firebrick	300, 303, 312, 377
- Miscellaneous	**Inorganic (Metal and Others) Residues** - Miscellaneous	197, 320, 360, 370, 438, 480
Scrub Alloy	**Scrub Alloy**	025, 600, 602, 603, 604, 620

Table B-4 lists the Resource Conservation and Recovery Act hazardous waste codes that may be associated with the residues identified in this EIS. They are distinguished by either characteristic or listed number. Descriptions of the characteristics and listing criteria associated with the Resource Conservation and Recovery Act codes are provided in Part 261.22-33 of 6 CCR 1007-3 or 40 CFR 261.22-33.

Table B–4 Resource Conservation and Recovery Act Hazardous Waste Codes Associated with This EIS

Characteristic	*Listed*
D001 - Ignitability	F001 - The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons

D002 - Corrosivity	F002 - The following spent halogenated solvents: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane
D003 - Reactivity	F003 - The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol
D004 - Arsenic	F005 - The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethylethanol, and 2-nitropropane
D005 - Barium	F006 - Wastewater treatment sludges from electroplating operations
D006 - Cadmium	F007 - Spent cyanide plating bath solutions from electroplating operations
D007 - Chromium	F009 - Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process
D008 - Lead D009 - Mercury D010 - Selenium D011 - Silver D018 - Benzene D019 - Carbon Tetrachloride D035 - Methyl Ethyl Ketone	

The sections that follow include estimates of the bulk and plutonium quantity for either the IDCs or the group of IDCs that are above the safeguards termination limits. The figures in Attachment 1, using process flow diagrams, show how the residues were generated.

B.3.2 Ash Residues

The subcategories under ash residues include incinerator ash; inorganics; sand, slag, and crucible; and graphite fines. These residues are grouped together because they are chemically alike or because they will be processed and repackaged in a similar way. According to the Solid Residues Environmental Assessment, these ash residues will be calcined, cemented if necessary, and repackaged to meet interim safe storage criteria. The baseline processing of these residues removes moisture and organics that may generate flammable or corrosive gases posing risks to workers and the public, convert plutonium metals and other metals to an oxide, and immobilize respirable fines to reduce dispersible risks. Approximately 72 percent of this category (approximately 20,100 kg [44,300 lb]) may require additional processing. Further discussions follow on the Item Description Codes within each subcategory that may require additional processing.

B.3.2.1 Incinerator Ash Residues

See Attachment 1

Figure B–1 shows the sources and types of incinerator ash residues generated at Rocky Flats; Figures B–11 and B–12 show the generation of IDC 421; and Figure B–12 shows the generation of IDC 378.

Incinerator ash residues are materials resulting from the combustion of feed materials during the operation of the residue recovery incinerator in Building 771 and strip-out operations of the incinerator in Building 371, though plutonium materials were never processed in Building 371. The Item Description Codes (IDCs) included in this subcategory are 378, 419, 420, 421, 422, and 428. These IDCs are classified as mixed residues. They are described in the following paragraphs:

- **IDC 378, Firebrick, Pulverized or Fines—**IDC 378 was generated in the residue recovery incinerators in Building 771; the firebrick was used to line the incinerator. The fines were generated from the scarfing of firebrick to remove plutonium. This material consists of firebricks, pulverized firebrick or firebrick fines, and chunks of high-density aluminum ceramic material in various sizes. This IDC contains plutonium and americium oxides, metal oxides, and high-density aluminum substrate material, which are packaged in 55-gallon drums and stainless steel slip lid cans.

- **IDC 419, Unpulverized Incinerator Ash—**This ash category is a nonhomogeneous material containing partially burned feed materials (combustibles) that vary in size from fine particulates that will pass through a 100-mesh screen to relatively large pieces of material. This ash contains measurable quantities of organics and carbon and was generated in the Building 771 residue recovery incinerator system and the Building 371 incinerator strip-out operations (ash from Building 371 was generated during nonplutonium tests). The ash is stored in 55-gallon drums or stainless steel slip lid cans.

- **IDC 420, Pulverized Incinerator Ash—**This ash category is a nonhomogeneous mixture that was crushed through a ball mill and contains a mixture of coarse, granular, fine, and very fine particulates. The ash, which contains some bits of metal, organics, and carbon, was generated in the Building 771 residue recovery incinerator system and in Building 371 incinerator strip-out operations (no plutonium material was processed in Building 371). The ash is stored in 55-gallon drums, stainless steel slip lid cans, plastic bottles, and other special containers.

Table B–5 presents the analyses of the composition of ash for IDC 419 and IDC 420.

Table B–5 Incinerator Ash Analyses for IDC 419 and IDC 420

Constituent	*Ash*	
	Range (Weight %)	*Average (Weight %)*
Al_2O_3	0.95 to 5.7	3.33
AmO_2	0.02	–
B_2O_3	0.32 to 3.2	1.76
BaO	0.58 to 1.2	0.89
CaO	1.1 to 7.0	4.05
Cr_2O_3	0.44 to 0.88	0.66
CuO	0.63 to 1.3	0.97
Fe_2O_3	1.1 to 10.3	5.70
K_2O	0.24 to 1.2	0.72
MgO	0.83 to 8.3	4.57
MnO_2	0.03 to 0.08	0.06
Na_2O	0.0 to 2.4	1.20
NiO	0.25 to 0.64	0.45
P_2O_5	0.23	–
PbO	0.58 to 0.92	0.75
PuO_2	1.8 to 3.8	2.80
SnO	0.0 to 0.25	0.13
Ta_2O_5	0.0 to 0.73	0.37
TiO_2	1.0 to 1.7	1.35
C	7.5 to 36.0	21.75
SiO_2	14.17 to 74.10	48.49
Weight Loss	–	–

Constituent	*Ash*	
	Range (Weight %)	*Average (Weight %)*
Total	–	100.00

- **IDC 421, Ash Heel—**Incinerator ash heel was generated from processing incinerator ash (IDCs 419 and 420) in Building 771; it is the insoluble residue (ash heel) that remains after ash dissolution in nitric acid. The ash heel is fairly homogeneous and contains fine to very fine particulates. It is stored in 55-gallon drums, stainless slip lid cans, bottles, and other special containers. This material will contain the same constituents as incinerator ash but in different concentrations. **Table B–6** presents the analysis of the composition of this ash heel.

- **IDC 422, Soot—**Incinerator soot is the incomplete combustion product from incinerator operations and is a mixture of fine to very fine fly ash. This material was generated in Building 771 during incineration operations and was collected during filter change operations of the incinerator plenum and during incinerator stripout operations in Building 371, though no plutonium was processed in Building 371. The soot is fairly homogeneous and is stored in 55-gallon drums. The soot composition generally has silica and carbon as the major components and aluminum oxide, calcium oxide, ferric oxide, and sodium oxide as the minor components.

Table B–6 Incinerator Ash Analysis of IDC 421

Constituent	*Ash*	
	Range (Weight %)	*Average (Weight %)*
Al_2O_3	1.1 to 7.2	4.15
AmO_2	0.02	–
B_2O_3	0.02 to 3.2	1.61
BaO	0.06 to 0.58	0.32
CaO	1.1 to 5.60	3.35
Cr_2O_3	0.58 to 2.9	1.74
CuO	0.06 to 0.5	0.28
Fe_2O_3	0.72 to 11.7	6.21
K_2O	0.02 to 0.6	0.31
MgO	0.83 to 1.7	1.27
MnO_2	0.03 to 0.16	0.10
Na_2O	0.0 to 1.2	0.60
NiO	0.25 to 0.64	0.45
P_2O_5	0.0 to 2.3	1.15
PbO	0.09 to 0.58	0.34
PuO_2	1.6 to 16.4	9.00
SnO	0.0 to 0.38	0.19
Ta_2O_5	0.61 to 1.2	0.91
TiO_2	1.0 to 5.0	3.00
C	10.4 to 44.8	27.60
SiO_2	0.00 to 81.53	37.42
Weight Loss	–	–
Total	–	100.00

❒ **IDC 428, Ash Selected for the Materials Management Executive Committee—**This ash is pulverized incinerator ash selected from IDC 420 that was set aside at the request of DOE's Materials Management Executive Committee for shipment and processing at another DOE site. The Committee was active in the 1980s.

Table B–7 shows the total bulk and plutonium concentrations for the incinerator ash residues.

Table B–7 Incinerator Ash Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
378	Firebrick, Pulverized or Fines	284	13.6	26.2	10.8	5.0	9.2	79.4
419	Unpulverized Incinerator Ash	29.2	1.8	29.2	1.8	2.0	100	100
420	Pulverized Incinerator Ash	10,031	696	8,497	679	2.0	84.7	97.6
421	Ash Heel	8,905	270	5,244	211	2.0	58.9	77.9
422	Soot	666	12	242	5.9	2.0	36.4	50.4
428	Ash Selected for MMEC	18.2	1.3	18.2	1.3	2.0	100	100

Pu = Plutonium STL = Safeguards Termination Limit MMEC = Materials Management Executive Committee

The number and types of packages for each IDC are given in **Table B–8**. These packages are either 55-gallon drums or other containers. Other containers are defined as cans, bottles, or other special receptacles.

Table B–8 Number and Types of Packages of Incinerator Ash Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
378	Firebrick, Pulverized or Fines	4	36	0	29
419	Unpulverized Incinerator Ash	3	2	3	2
420	Pulverized Incinerator Ash	783	13	749	10
421	Ash Heel	327	4	256	3
422	Soot	18	0	7	0
428	Ash Selected for MMEC	1	10	1	10

STL = Safeguards Termination Limit MMEC = Materials Management Executive Committee.

Table B-9 provides the Resource Conservation and Recovery Act hazardous waste codes that are associated with the applicable IDCs for Incinerator Ash Residues. Not all packages in each IDC have all the waste codes assigned.

Table B–9 Resource Conservation and Recovery Act Hazardous Waste Codes for Incinerator Ash Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
378	Firebrick, Pulversized or Fines	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F005
419	Unpulverized Incinerator Ash	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F005
420	Pulverized Incinerator Ash	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F003, F005
421	Ash Heel	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F003, F005
422	Soot	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F005

428	Ash Selected for MMEC	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F003, F005

B.3.2.2 Graphite Fines Residues

Graphite fines residues were generated in Buildings 371, 707, 771, and 777. Graphite was used as mold material in plutonium foundry operations. The Item Description Code (IDC) is 310 and is described in the following paragraph:

See Attachment 1
Figure B–2 shows the source and type of graphite fines residues.

- **IDC 310, Graphite Scarfings and Fines—**Graphite scarfings and fines residues were generated in Buildings 771, 371, 777, and 707 during plutonium foundry operations and graphite scarfing operations. Graphite molds were mechanically cleaned to remove the mold coating and plutonium embedded on the graphite surface. The resulting fines and small pieces were identified as IDC 310. These residues contain a mixture of granular, fine, and very fine particulates. The matrix is mostly graphite containing small quantities of calcium fluoride and calcium and magnesium metals or oxides with plutonium metals and oxides. IDC 310 was packaged into 55-gallon drums and stainless steel slip lid cans.

Table B–10 shows the total bulk and plutonium concentrations for the graphite fines residues.

Table B–10 Graphite Fines Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
310	Graphite Scarfings and Fines	946	74.3	899	74.0	1.0	95.0	99.6

Pu = Plutonium STL = Safeguards Termination Limit

The number and types of packages for IDC 310 are given in **Table B–11**.

Table B–11 Number and Types of Packages of Graphite Fines Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
310	Graphite Scarfings and Fines	84	26	81	26

STL = Safeguards Termination Limit

There are no Resource Conservation and Recovery Act hazardous waste codes associated with the IDC for Graphite Fines Residues.

B.3.2.3 Sand, Slag, and Crucible Residues

See Attachment 1

Figure B–3 shows most of the sources and types of sand, slag, and crucible residues. Figure B–12 shows the generation of IDCs 333, 393, 396, and 398.

Sand, slag, and crucible residues were generated in Building 771 during reduction and button breakout, dissolution system, and preparatory plutonium recovery processes (crushing and grinding). Additionally, small quantities of residues were generated in the research and development gloveboxes in Building 779 and during an attempted start-up of processes in Building 371. The Item Description Codes (IDCs) included in this subcategory are 333, 387, 390, 391, 392, 393, 394, 395, 396, and 398. IDCs in this subcategory are described in the following paragraphs:

- **IDC 333, Calcium Metal—**IDC 333 originated from Building 771 metal reduction operations. The material consists of calcium metal contaminated with plutonium oxide and plutonium fluoride.

- **IDC 387, Reburned Sand, Slag, and Crucible Sweepings—**IDC 387 is material generated from the cleanup of sand, slag, and crucible from the reduction process gloveboxes in Building 771 that was then heated to stabilize the material (oxidize any reactive metals). Additionally, small quantities of IDC 387 were generated in the research and development gloveboxes in Building 779. This material consists of granular, fine, and very fine materials stored in stainless steel slip lid cans.

- **IDC 390, Unpulverized Slag; IDC 391, Unpulverized Sand and Crucible; IDC 392, Unpulverized Sand, Slag, and Crucible; IDC 394, Sand from Button Breakout; IDC 395, Unpulverized Slag and Crucible; IDC 396, Pulverized Slag; IDC 398, Pulverized Sand, Slag, and Crucible—**IDCs 390, 391, 392, 394, 395, 396, and 398 were generated in Building 771 from the reduction and button breakout process and during start-up of Building 371 recovery processes. The unpulverized slag (IDC 390) was generated when the slag was separated from the sand and crucible (IDC 391) following the removal of the plutonium button. The slag is nonhomogeneous and is a mixture of coarse chunks of calcium fluoride; it contains uncoalesced plutonium metal, excess calcium metal, magnesium metal, plutonium fluoride, and magnesium oxide sand. The sand and crucible residue may contain uncoalesced plutonium metal, calcium metal, magnesium metal, calcium fluoride slag, and trace amounts of a pyrotechnic initiator that contains potassium iodide and sodium peroxide. The residue will range in size from chunks of the magnesium oxide crucible to grains of sand. IDC 392 consists of IDCs 390 and 391 that were not separated. IDC 394 consists of magnesium oxide sand (for reuse in the process) that was screened from the sand, slag, and crucible. The slag and crucible generated during the screening of the sand is IDC 395.

  IDC 396 was generated from the crushing and grinding of IDC 390 in the Building 771 jaw crusher and hammer mill in preparation for the dissolution process. The pulverized slag consists of granular to very fine particles, with the same composition as IDC 390. IDC 398 was also generated in the Building 771 jaw crusher and hammer mill from the crushing and grinding of magnesium oxide sand, calcium fluoride slag, and crucibles in preparation for dissolution. The pulverized sand, slag, and crucible consists of coarse to very fine particles and has the same constituents as IDC 392. IDCs 396 and 398 were generated to be eventually processed through the Building 771 dissolution process to recover any plutonium within these IDCs.

- **IDC 393, Sand, Slag, and Crucible Heel—**Sand, slag, and crucible heel was generated in the Building 771 dissolution process from the feed materials identified as IDCs 396 and 398. IDCs 396 and 398 were dissolved in nitric acid and aluminum nitrate, and the solution was filtered to remove any undissolved solids. The undissolved solids (IDC 393) were dried and packaged to await further plutonium recovery. IDC 393

consists of coarse to very fine materials and contains constituents similar to the feed materials, except that the reactive materials have been oxidized.

Table B–12 shows the total bulk and plutonium concentrations for sand, slag, and crucible residues.

Table B–12 Sand, Slag, and Crucible Residue IDCs That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
333	Calcium Metal	2.70	0.21	2.70	0.21	0.2	100	100
387	Reburned SS&C Sweepings	3.62	1.55	3.62	1.55	0.2	100	100
390	Unpulverized Slag	20.8	2.95	20.6	2.95	0.2	99.0	100
391	Unpulverized Sand and Crucible	758	28.4	746	28.4	0.2	98.5	100
392	Unpulverized SS&C	1,614	55.3	1,608	55.3	0.2	99.6	100
393	SS&C Heel	325	6.7	53.8	4.32	2.0	16.6	64.5
394	Sand from Button Break-out	78.5	8.13	67.1	8.13	0.2	85.5	100
395	Unpulverized Slag and Crucible	29.8	0.564	29.8	0.564	0.2	100	100
396	Pulverized Slag	0.884	0.03	0.884	0.027	0.2	100	100
398	Pulverized SS&C	529	27.4	529	27.4	0.2	100	100

Pu = Plutonium STL = Safeguards Termination Limit SS&C = Sand, Slag, and Crucible

The number and types of packages for each IDC are given in **Table B–13**.

Table B–13 Number and Types of Packages of Sand, Slag, and Crucible Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
333	Calcium Metal	1	1	1	1
387	Reburned SS&C Sweepings	0	4	0	4
390	Unpulverized Slag	4	1	4	0
391	Unpulverized Sand and Crucible	28	150	26	144
392	Unpulverized SS&C	62	44	62	38
393	SS&C Heel	18	0	9	0
394	Sand from Button Break-out	9	10	9	7
395	Unpulverized Slag and Crucible	0	9	0	9
396	Pulverized Slag	0	1	0	1
398	Pulverized SS&C	27	10	27	10

STL = Safeguards Termination Limit SS&C = Sand, Slag, and Crucible

There are no Resource Conservation and Recovery Act hazardous waste codes associated with the IDCs for sand, slag, and crucible residues.

B.3.2.4 Inorganic Ash Residues

Inorganic ash residues result from production operations. At Rocky Flats, these residues were generated in

See Attachment 1

Figures B–4, B–5, B–6, and B–12 show the sources and types of inorganic ash residues (IDCs 368 and H61) generated at Rocky Flats.

Buildings 371, 707, 776, 771, and 779. The Item Description Codes (IDCs) included in this category are 368 and H61; they are described in the following paragraphs:

- **IDC 368, Magnesium Oxide Ceramic Crucible—**IDC 368 was generated from electrorefining, reduction, direct oxide reduction, and salt scrub processes in Buildings 371, 771, 776, and 779. Typically, the material consists of the spent magnesium oxide ceramic crucibles that were broken to remove the contents of the crucible. This IDC is nonhomogeneous and consists of irregularly shaped pieces of magnesium oxide containing salt residue from pyrochemical processing and possibly reactive metals. The particle size ranges from dust (1 to 25 microns [0.000039 to 0.00098 inches]) to large chunks (5.1 to 7.6 centimeters [2 to 3 inches]).

- **IDC H61, Oxide from Ducts—**Oxides from ducts residue were generated from duct remediation and cleanout activities in Buildings 371, 707, 771, and 776 and are a powder-like material that is 1 to 25 microns (0.000039 to 0.00098 inches) in size. This oxide is low in plutonium content. **Table B–14** shows the major components in oxide form.

Table B–15 shows the total bulk and plutonium concentrations for the inorganic ash residues.

The number and types of packages for each IDC are given in **Table B–16**.

Table B–14 Oxide from Ducts, IDC H61

Constituent	*%*
Plutonium	18
Calcium	40
Carbon	21
Chlorine	6
Aluminum	9
Iron	2
Lanthanum	1
Silicon	1
Magnesium	1

Table B–15 Inorganic Ash Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
368	Magnesium Oxide Ceramic Crucible	3,330	47.4	2,003	46	0.2	60.2	96.6
H61	Oxide from Ducts	40	4.9	40	4.9	0.2	100	100

Pu = Plutonium STL = Safeguards Termination Limit

Table B–16 Number and Types of Packages of Inorganic Ash Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
368	Magnesium Oxide Ceramic Crucible	59	164	46	162
H61	Oxide from Ducts	0	75	0	75

STL = Safeguards Termination Limit

Table B-17 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDC for Inorganic Ash Residues. Not all packages in each IDC have all the waste codes assigned.

Table B–17 Resource Conservation and Recovery Act Hazardous Waste Codes for Inorganic Ash Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
368	Magnesium Oxide Ceramic Crucible	D005, D008

B.3.3 Salt Residues

The subcategories within the salt residues requiring additional processing are electrorefining salts, molten salt extraction salts, and direct oxide reduction salts. These residues are grouped together based on their chemical similarity. Most of the electrorefining and molten salt extraction salts consist of sodium chloride, potassium chloride, and magnesium chloride; the major differences are the concentrations of plutonium, americium, and magnesium chlorides. All salts in the direct oxide reduction subcategory contain calcium chloride; however, because many processes used calcium chloride (e.g., direct oxide reduction, molten salt extraction, and pyroredox), the salt residues in the direct oxide reduction subcategory contain a variety of salt mixtures with the calcium chloride, including calcium oxide, cesium chloride, zinc chloride, and potassium chloride.

Grouping the salt residues based on the chemical composition is not straightforward. For example, there are two types of molten salt extraction salt residues: residues with a sodium chloride/potassium chloride salt matrix (IDCs 405–410 and 418) and residues with a calcium chloride salt matrix (IDC 427). The IDC 427 residue could have been grouped with IDCs 405–410 and 418 in the molten salt extraction subcategory (high americium) or with the direct oxide reduction subcategory (calcium chloride). The IDC 427 residue was included in the direct oxide reduction subcategory in this EIS because the salt distillation process for the molten salt extraction subcategory is not applicable to calcium chloride salts.

Approximately 93 percent of this inventory (about 14,900 kg [32,800 lb]) would require additional processing to meet the Safeguards Termination Limits. Further discussions on the IDCs within each of the subcategories follow.

B.3.3.1 Electrorefining Salt Residues

The electrorefining salt residues are materials resulting from the electrorefining stationary furnaces in Buildings 776 and 779 and from the tilt pour furnaces in Buildings 371 and 776. The major constituents in electrorefining salt residues are sodium chloride and

See Attachment 1
Figure B–4 shows the sources and types of electrorefining salt residues generated at Rocky Flats.

potassium chloride. The Item Description Codes (IDCs) included in this subcategory are 411, 473, 654, and 655. They are described in the following paragraphs:

- **IDC 411, Electrorefining Salt; IDC 473, Electrorefining Salt Packaged for Los Alamos National Laboratory; and IDC 654, Electrorefining Salt from Plutonium/Neptunium—**IDCs 411, 473, and 654 are the salts generated from the "tilt-pour" electrorefining furnaces in Buildings 371 and 776 and the stationary electrorefining furnaces in Buildings 776 and 779 during the purification of nonspecification plutonium metal. A tilt-pour furnace melts material and then tilts to remove the material from the furnace. These electrorefining salts are nonhomogeneous and are a mixture of chunks, granular, and fine particulates; they may contain plutonium chloride, americium chloride, minor amounts of magnesium chloride, and possibly small amounts of free sodium. The electrorefining salts may also contain plutonium oxides. IDC 654 was generated on a limited scale from experimental runs to study neptunium distribution within plutonium. Electrorefining salt may also contain free potassium metal and such reactive metals as calcium, magnesium, plutonium, and neptunium. IDC 473 is the same as IDC 411 that has been repackaged for shipment to Los Alamos National Laboratory. Residue IDCs 411, 473, and 654 may be packaged in 55-gallon drums or other containers.

- **IDC 655, Electrorefining Ceramics from Plutonium/Neptunium—**Electrorefining ceramics from plutonium/neptunium residues were generated in the electrorefining furnaces in Buildings 776 and 779, on a limited basis, when electrorefining processing of plutonium-neptunium alloys was performed. Once the crucible containing the alloy was cooled, the crucible was broken, the contents removed, and the broken crucible was identified as IDC 655. This IDC is composed of broken pieces of crucibles and contains coated magnesium oxide with pyrochemical salts and reactive metals, such as calcium, magnesium, plutonium, and neptunium. IDC 655 residues may be packaged in 55-gallon drums, stainless steel slip lid cans, or produce cans.

Table B–18 shows the total bulk and plutonium concentrations for the electrorefining salt residues.

Table B–18 Electrorefining Salt Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
411	Electrorefining Salt	7,371	470	7,211	470	0.2	97.8	>99.9
473	Electrorefining Salt Packaged for LANL	176	12.9	176	12.9	0.2	100	100
654	Electrorefining Salt from Pu/Np	28.3	4.80	28.3	4.80	0.2	100	100
655	Electrorefining Ceramics from Pu/Np [a]	5.54	0.498	5.54	0.498	0.2	100	100

Pu = Plutonium STL = Safeguards Termination Limit LANL = Los Alamos National Laboratory Pu/Np = Plutonium/neptunium

[a] These residues may be processed with sand, slag, and crucibles.

The number and types of packages for each IDC are given in **Table B–19**.

Table B–19 Number and Types of Packages of Electrorefining Salt Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
411	Electrorefining Salt	167	2,282	166	2,277
473	Electrorefining Salt Packaged for Los Alamos National Laboratory	11	49	11	49
654	Electrorefining Salt from Pu/NP	1	15	1	15
655	Electrorefining Ceramics from Pu/NP	1	2	1	2

STL = Safeguards Termination Limit Pu/Np = Plutonium/neptunium

There are no Resource Conservation and Recovery Act hazardous waste codes associated with the IDCs for electrorefining salt residues.

B.3.3.2 Molten Salt Extraction Salt Residues

See Attachment 1

Figures B–5 and B–12 show the sources and types of molten salt extraction salt residues generated at Rocky Flats.

Molten salt extraction was used to remove americium from plutonium metal. Aged plutonium metal, such as metal returning to Rocky Flats from the nuclear weapons stockpile, slowly builds up in americium content from the radioactive decay of plutonium-241. Americium-241 has some low energy but intense gamma radiation that increases personnel exposure when handling the material. Molten salt extraction salt residues are materials resulting from the molten salt extraction process. Stationary furnaces for molten salt extraction were located in Buildings 776 and 779. The residue Item Description Codes (IDCs) included in this subcategory are IDCs 044, 405, 406, 407, 408, 409, 410, 418, 429, and 601. IDCs in this subcategory are described in the following paragraphs:

- **IDC 044, Americium and Miscellaneous Oxide—**IDC 044 was generated in Building 771 in the americium purification process.

- **IDC 405, Molten Salt, Unknown Percent Unpulverized; IDC 406, Molten Salt, Unknown Percent Pulverized; IDC 407, Molten Salt, 8 Percent Unpulverized; IDC 408, Molten Salt, 8 Percent Pulverized; IDC 409, Molten Salt, 30 Percent Unpulverized; IDC 410, Molten Salt, 30 Percent Pulverized; IDC 418, Molten Salt Packaged for Los Alamos National Laboratory—**Molten salt extraction salts categorized with IDCs 405 through 410 and IDC 418 were generated in Building 776 during the molten salt extraction production recovery processes and in Building 779 from nonproduction operations with varying percentages of magnesium chloride. The molten salt extraction process removed americium from aged plutonium metal and produced an americium deficient plutonium metal, molten salt extraction salts containing the americium, and other residues such as crucible materials and metal stirrers. Molten salt extraction salts are nonhomogeneous and are in the form of chunks, pulverized and unpulverized, and may contain sodium chloride, potassium chloride, magnesium chloride, plutonium oxides and chlorides, americium chlorides and oxides, and elemental magnesium and plutonium. The descriptions of the IDCs denote the original percentage of magnesium chloride in the reagent salt and whether the salt was pulverized. IDC 418 is the same as IDC 410 and is material that had been repackaged for shipment to the Los Alamos National Laboratory. These materials are packaged in 55-gallon drums and other containers.

- **IDC 429, Scrub Alloy Spent Salt—**IDC 429 residues are salts remaining from the salt scrub process. The major components of IDC 429 include sodium chloride and potassium chloride but also may include magnesium chloride, magnesium oxide, and residual amounts of plutonium and americium compounds (metal, chloride, and oxide). This subcategory of residues is nonhomogeneous and is in the form of chunks and fines.

- **IDC 601, Aluminum-Magnesium Oxide—**IDC 601 was generated during nonproduction activities in the scrub alloy process from molten salt extraction salts in Buildings 776 and 779. The material contains the crucible pieces and aluminum oxide residue remaining in the crucible after the alloy button is removed. The crucibles are contaminated with salts, plutonium, and small amounts of sodium metal.

Table B–20 shows the total bulk and plutonium concentrations for the molten salt extraction residues.

Table B–20 Molten Salt Extraction Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
044	Americium and Miscellaneous Oxide [a]	3.19	0.73	3.19	0.73	0.2	100	100
405	Molten Salt, Unknown % Unpulverized	1,539	32.2	1,451	32.0	0.2	94.3	99.7
406	Molten Salt, Unknown % Pulverized	24.3	5.10	24.3	5.10	0.2	100	100
407	Molten Salt, 8% Unpulverized	463	16.2	463	16.2	0.2	100	100
408	Molten Salt, 8% Pulverized	210	4.8	210	4.8	0.2	100	100
409	Molten Salt, 30% Unpulverized	1,474	237	1,474	237	0.2	100	100
410	Molten Salt, 30% Pulverized	17.6	3.78	17.5	3.78	0.2	99.4	100
418	Molten Salt Packaged for LANL	49.5	10.1	49.5	10.1	0.2	100	100
429	Scrub Alloy Spent Salt	1,748	14.0	1,602	13.8	0.2	91.7	98.7
601	Aluminum Magnesium Oxide [a]	1.18	0.31	1.18	0.31	0.2	100	100

Pu = Plutonium STL = Safeguards Termination Limit LANL = Los Alamos National Laboratory
[a] This residue may be processed with sand, slag, and crucibles.

The number and types of packages for the IDC are given in **Table B–21.**

Table B–21 Number and Types of Packages of Molten Salt Extraction Salt Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
044	Americium and Miscellaneous Oxide	1	3	1	3
405	Molten Salt, Unknown % Unpulverized	29	4	28	4
406	Molten Salt, Unknown % Pulverized	0	24	0	24
407	Molten Salt, 8% Unpulverized	18	5	18	5
408	Molten Salt, 8% Pulverized	6	0	6	0
409	Molten Salt, 30% Unpulverized	272	24	272	24
410	Molten Salt 30% Pulverized	4	2	4	1
418	Molten Salt Packaged for Los Alamos National Laboratory	0	32	0	32
429	Scrub Alloy Spent Salt	44	2	40	2
601	Aluminum Magnesium Oxide	0	2	0	2

STL = Safeguards Termination Limit

There are no Resource Conservation and Recovery Act hazardous waste codes associated with the IDCs for molten extraction salt residues.

B.3.3.3 Direct Oxide Reduction Salt Residues

All of the salts in this subcategory contain calcium chloride. The salts were generated from several processes, including direct oxide reduction, molten salt extraction, salt scrub, and pyroredox. The processing was done in stationary furnaces.

See Attachment 1
Figures B–5, B–6, and B–12 show the sources and types of direct oxide reduction and other salt residues generated at Rocky Flats.

Calcium chloride is used as a flux in the direct oxide reduction process to promote coalescence of plutonium metal during the reduction of plutonium oxide by calcium metal to produce high yields of plutonium metal as a product. Calcium oxide, a byproduct of the reduction, also is present in the salt residue.

Some of the calcium chloride salts were scrubbed to remove plutonium and americium, analogous to the salt scrub process for sodium chloride/potassium chloride salts.

The pyroredox process purified impure plutonium metal. In the oxidation step of the pyroredox process, impure plutonium metal was heated with zinc chloride in a calcium chloride/potassium chloride salt flux. The plutonium and more reactive impurities were oxidized into the salt by the zinc chloride; that resulting salt was identified as IDC 415. The plutonium in the IDC 415 salts was reduced with calcium in the next step of the pyroredox process; those residues were identified as IDC 412. The plutonium metal from the reduction step was contaminated with calcium and zinc, which were removed with a vacuum melt process; the vacuum melt residues were identified as IDC 416.

The residue IDCs included in this subcategory are IDCs 365, 404, 412, 413, 414, 415, 416, 417, 427, 433, 434, and 435. IDCs in this subcategory are described in the following paragraphs:

- **IDC 365, Salt from Bad Direct Oxide Reduction Run—**IDC 365 was generated from the stationary furnaces in Building 776 and from nonproduction operations in Building 779. IDC 365 was generated from failed direct oxide reduction runs and consists of mixtures of the calcium chloride, calcium oxide, plutonium oxide, plutonium metal, and calcium metal. A direct oxide reduction run was considered a failure any time the quantity of unreduced plutonium oxide exceeded the acceptable limit. It contains plutonium in the form of chunks and fines, and is nonhomogeneous.

- **IDC 404, Molten Salt, Calcium, Zinc, Potassium—**IDC 404 residue is a salt generated from a nonproduction process performed in Building 776. This process used sodium chloride, potassium chloride, and magnesium chloride as the basic reagent salt mixture and was enhanced with zinc chloride and calcium chloride to improve the extraction process. This IDC is nonhomogeneous and consists of chunks of fused salts with high concentrations of americium and plutonium chloride, zinc metal, plutonium and americium compounds, and possibly sodium and potassium metal.

- **IDC 412, Gibson Salts—**Gibson salt residues were generated from the plutonium reduction step of the Pyroredox process in Buildings 776 and 779. The Gibson salt residues may contain potassium chloride; plutonium chloride; zinc chloride; and minor amounts of chlorides of chromium, zirconium, titanium, vanadium, niobium, manganese, americium, uranium, and neptunium; and small amounts of aluminum and silicon.

- **IDC 413, Impure Salt from Cell Cleanout—**Residues within IDC 413 were generated by the cell cleanout from molten salt extraction and electrorefining salt processes both in the stationary furnaces in Building 776 and in the tilt-pour furnaces in Building 371; the residues were stored for future processing. Additionally, small amounts of residues were generated in nonproduction operations in Building 779 during cell cleanout. This salt residue is composed of chunks, granular, and fine particulates containing americium chloride, plutonium chloride, sodium chloride, potassium chloride, calcium chloride, small amounts of magnesium chloride, and possibly small amounts of free sodium. It is possible that residues generated in Building 779 and those generated in Building 776 during the early 1980s and after March 1989 may contain calcium chloride. IDC 413 residues may be packaged in 55-gallon drums, stainless steel slip lid cans, plastic bottles, produce cans, or special containers.

- **IDC 414, Direct Oxide Reduction Salt, Unoxidized Calcium—**IDC 414 is a direct oxide reduction salt originating from the direct oxide reduction process in Building 776 and for nonproduction operations in Building 779. This IDC is nonhomogeneous, may contain calcium oxide, calcium metal, calcium chloride and plutonium oxide, and is in the form of chunks and fines.

- **IDC 415, Plutonium Chloride Mixed Salt—**IDC 415 residues were generated from the plutonium oxidation step of the Pyroredox process and may include potassium chloride, calcium chloride, plutonium chloride, americium chloride, zinc chloride, aluminum chloride, lithium chloride, cesium chloride, copper chloride, gallium chloride, tantalum chloride, and tungsten chloride. This salt is a mixture of chunks, granular, and fine particulates. IDC 415 residues are packaged in 55-gallon drums and stainless steel slip lid cans.

- **IDC 416, Zinc-Magnesium Alloy Metal—**IDC 416 was generated during the Building 776 and Building 779 vacuum melt process, used to remove contaminants (calcium, magnesium, and zinc) from plutonium metal produced in the reduction step of the Pyroredox process. It is a zinc/magnesium alloy in a powdery form that contains plutonium.

- **IDC 417, Dicesium Hexacloroplutonate (DCHP)—**IDC 417 was used as an oxidant to extract americium from molten plutonium metal. IDC 417 was generated in Building 371 and Building 779 to support Pyrochemical processing in Building 776. IDC 417 was also generated as a Research and Development material in Building 771 and Building 779.

- **IDC 427, Molten Salt Extraction Spent Dicesium Salt—**IDC 427 is spent salt produced from the molten salt extraction process and consists of calcium chloride, cesium chloride, americium chloride, plutonium chloride, plutonium oxide, and elemental plutonium. The material is in the form of chunks with some material pulverized into fines.

- **IDC 433, Scrub Alloy Spent Dicesium Salt—**IDC 433 residue was generated from scrubbed molten salt extraction spent dicesium salts (IDC 427) using a magnesium/aluminum scrub process. IDC 433 salts are composed of a mixture of calcium chloride and cesium chloride.

- **IDC 434, Free Calcium Containing Spent Salt—**IDC 434 was generated in Building 779 from scrubbed molten salt extraction spent dicesium salts (IDC 427) using a calcium/gallium scrub process. The material is a salt phase byproduct of the calcium-gallium scrub alloy of the molten salt extraction Process Development effort. Some additional IDC 434 was generated in Building 776 as part of the calcium/ gallium salt scrub process demonstration in the fall of 1989. IDC 434 is nonhomogeneous and may contain chunks and fine particles. The salt matrix is the same as that of IDC 433.

❒ **IDC 435, Cerium/Calcium Scrub Alloy Spent Salts—**Cerium/calcium scrub alloy spent salts were generated as a byproduct of a salt scrub development program in Building 779, where a cerium/calcium metal alloy was tested as a substitute for the normal aluminum/magnesium alloy routinely used in the molten salt extraction process. The salts were produced in a standard stationary furnace and ceramic crucibles. The spent molten salt extraction salts were heated to a molten state, stirred with molten alloy, allowed to cool, and separated from the solidified metal alloy button. Initial test results were not favorable, so the process development was stopped. The salt residues are composed of calcium chloride; cesium chloride; cerium chloride; plutonium and americium chlorides, metals, and oxides; and elemental calcium and cerium. The material consists of dry, fused salts in the form of chunks and fines.

Table B–22 shows the total bulk and plutonium concentrations for the direct oxide reduction residues.

Table B–22 Direct Oxide Reduction Salt Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of IDC(s)*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
365, 414	Salt from Bad DOR Run, DOR Salt–Unoxidized Calcium	1,231	64.6	1,231	64.6	0.2	100	100
404	Molten Salt, Calcium, Zinc, Potassium	516	1.9	4.00	1.50	0.2	0.8	79.0
412	Gibson Salt	240	1.2	67.2	0.98	0.2	28.0	81.7
413	Impure Salt from Cell Cleanout	502	68.3	502	68.3	0.2	100	100
415	Plutonium Chloride Mixed Salt	122	6.84	122	6.84	0.2	100	100
416	Zinc-Magnesium Alloy Metal	4.77	0.39	4.77	0.39	0.2	100	100
417	Dicesium Hexachlorplutonate	63.0	20.9	63.0	20.9	0.2	100	100
427	Molten Salt Extraction Spent Dicesium Salt	194	44.9	194	44.9	0.2	100	100
433	Scrub Alloy Spent Dicesium Salt	21.0	0.31	21.0	0.31	0.2	100	100
434	Free Calcium Containing Spent Salt	18.4	2.02	17.8	2.02	0.2	96.7	100
435	Spent Cerium/Calcium Salt Scrub	7.7	0.2	7.7	0.2	0.2	100	100

Pu = Plutonium STL = Safeguards Termination Limit DOR = Direct Oxide Reduction

The number and types of packages for each IDC are given in **Table B–23**.

Table B–23 Number and Types of Packages of Direct Oxide Reduction Salt Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
365	Salt from Bad Direct Oxide Reduction Run	0	16	0	16
404	Molten Salt, Calcium, Zinc, Potassium	4	0	2	0
412	Gibson Salt	3	0	1	0
413	Impure Salt from Cell Cleanout	32	219	32	219
414	Direct Oxide Reduction Salt - Unoxidized Calcium	34	114	33	110
415	Plutonium Chloride Mixed Salt	8	18	8	18
416	Zinc-Magnesium Alloy Metal	0	3	0	3
417	Dicesium Hexachloroplutonate	4	65	4	65

IDC	Description	55-Gallon Drums (Total)	Other (Total)	55-Gallon Drums (Above STL)	Other (Above STL)
427	Molten Salt Extraction Spent Dicesium Salt	3	130	3	130
433	Scrub Alloy Spent Dicesium Salt	2	1	2	1
434	Free Calcium Containing Spent Salt	0	10	0	9
435	Spent Cerium/Calcium Salt Scrub	1	0	1	0

STL = Safeguards Termination Limit

There are no Resource Conservation and Recovery Act hazardous waste codes associated with direct oxide reduction salt residues.

B.3.4 Plutonium Fluoride Residues

See Attachment 1
Figures B–7 and B–12 show the sources and types of plutonium fluoride residues generated at Rocky Flats.

Plutonium fluoride residues are residue materials generated in fluoride conversion and metal reduction. Some of these residues are high plutonium content; however, the presence of fluoride results in a high neutron emission rate caused by alpha-neutron reactions between plutonium alpha particles and fluorine nucleus. These Item Description Codes (IDCs) were generated in Buildings 371 and 771. The IDCs included are 090, 091, 092, 093, and 097. IDCs in this subcategory are described in the following paragraphs:

- **IDC 090, Plutonium Tetrafluoride, and IDC 091, Nonspecification Fluoride—**IDC 090 and IDC 091 were generated in Building 771 from the reaction of anhydrous hydrogen fluoride with plutonium oxide to form plutonium tetrafluoride. These residues are in a powder form and are referred to as "pink cake." IDC 090 is feed for conversion to metal; IDC 091 material did not meet the purity specification for further processing into metal. Residue IDCs 090 and 091 are classified as mixed residues.

- **IDC 092, Impure Fluoride Heel, and IDC 097, Impure Fluoride Heel in Small Inner Cans—**Residues within IDCs 092 and 097 were generated in the dissolution process in Building 771 from residues within IDC 091. These residues are the dry heel resulting from this process and were packaged for further dissolution. IDCs 092 and 097 differ only in the type of packaging used. Residue IDCs 092 and 097 are mixed residues.

- **IDC 093, Sodium Fluoride Pellets—**Sodium fluoride pellet residues were generated in a Fluidized Bed Fluorination Process in Building 371 and in a Fluoride Volatility Study in Building 771. Sodium fluoride pellets were used to absorb small quantities of plutonium hexafluoride gas that were not converted to plutonium tetrafluoride.

Table B–24 shows the total bulk and plutonium concentrations for the plutonium fluoride residues.

Table B–24 Plutonium Fluoride Residues That Are Evaluated in this EIS

IDC	Residue	Kg of Total Bulk of this IDC	Kg of Pu in Total Bulk	Kg Bulk Requiring Processing	Kg of Pu in Bulk Requiring Processing	STL Pu Weight %	Bulk % > STL	Pu % > STL
090	Plutonium Tetrafluoride	2.38	–	2.38	–	0.2	100	100
091	Non-Specification Fluoride	185	–	185	–	0.2	100	100
092	Impure Fluoride Heel	40.5	–	40.5	–	0.2	100	100

093	Sodium Fluoride Pellets	70.6	–	69.5	–	0.2	98.5	99.99
097	Impure Fluoride in Small Inner Cans	18.0	–		–	0.2	100	100
090-093, 097	All Above Residues	316.5	141.5	315.4	141.5	0.2	99.7	~100

Pu = Plutonium STL = Safeguards Termination Limit

The number and types of packages for each IDC are given in **Table B–25**.

Table B–25 Number and Types of Packages of Plutonium Fluoride Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
090	Plutonium Tetrafluoride	0	5	0	5
091	Non-Specification Fluoride	0	129	0	129
092	Impure Fluoride Heel	0	30	0	30
093	Sodium Fluoride Pellets	0	59	0	58
097	Impure Fluoride in Small Inner Cans	0	34	0	34

STL = Safeguards Termination Limit

All of the material described by the above five IDCs were used as intermediate feedstocks for plutonium recovery and parts production. When Rocky Flats shut down at the end of 1989, the intention was to restart at the end of one month, so no effort was made to complete the processing of these materials. When the decision was made to end the manufacturing operations at Rocky Flats, thereby never restarting parts production operations, there was no other facility within the DOE Weapons Complex that used these materials. Therefore, they were stored as plutonium residues. Since it was determined by process knowledge and by some sampling and analysis that four of the five IDCs had material that might contain chromium, the IDCs were designated as "Resource Conservation and Recovery Act hazardous."

Table B-26 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDCs for Plutonium Fluoride Residues. Not all packages in each IDC have all the waste codes assigned.

Table B–26 Resource Conservation and Recovery Act Hazardous Waste Codes for Plutonium Fluoride Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
090	Plutonium Tetrafluoride	D007
091	Non-Specification Fluoride	D007
092	Impure Fluoride Heel	D007
097	Impure Fluoride in Small Inner Cans	D007

The Savannah River Site now would like to use the plutonium fluoride residues as feedstock for the Purex process in their process canyons. Based on this change to feedstock, the Colorado Department of Public Health and Environment has determined that the plutonium fluorides can be reclassified as feedstock once they are moved from storage and into the gloveboxes for packaging to ship to the Savannah River Site. At that point

they will cease to be managed as mixed waste and will be managed as feed material for the Savannah River Site. No Resource Conservation and Recovery Act hazardous waste codes will be associated with the fluorides once they enter the glovebox for repackaging to ship to the Savannah River Site.

B.3.5 Sludge Residues

See Attachment 1

Figures B–1 and B–8 show the sources and type of sludge residues generated at Rocky Flats. Figure B–7 and Figure B–8 show the sources and types of greases and oily sludge residues generated at Rocky Flats.

This category includes sludge residues and greases and oily sludge residues. Sludge residues are insoluble plutonium-bearing materials collected on filters from processing equipment. The sludges have been generated in Buildings 559, 371, 771, and 776. Greases and oily sludge residues are materials resulting from routine operations and inventory and cleanout operations. These materials were generated in Buildings 771, 776, and 777. The Item Description Codes (IDCs) in this subcategory are 089, 099, 290, 291, 292, 299, 332, and 340. They are described in the following paragraphs:

- **IDC 089, Grease Oxide (Green Cake)—**Material in IDC 089 originated from inventory and cleanout operations of the calcination process in Building 771. The calcination process converts precipitated plutonium peroxide, an unstable material, to stable plutonium oxide. The plutonium oxide powder is finely divided and, in the calcination process, becomes entrained on calciner wear plates and other rotating surfaces that need to be lubricated.

- **IDC 099, Grease Fluoride—**The material in IDC 099 originated from routine maintenance, inventory, and cleanout operations of the continuous hydrofluorination process in Building 771. This is a high plutonium content residue and is a mixture of plutonium fluoride, plutonium oxide, and grease. The plutonium powder is finely divided and, in the hydrofluorination process, becomes entrained on wear plates and other rotating surfaces that need to be lubricated.

- **IDC 290, Filter Sludge—**Filter sludges in IDC 290 were generated from the calcination processes in Building 771, from laboratory processes in Buildings 559 and 771, and from vacuum pumps and other process equipment in Building 771. The sludge is nonhomogeneous and ranges from a damp mass with the consistency of paste to a partially dried powder containing fines. IDC 290 may contain trace amounts of the following chemicals: alcohols/glycols (e.g., butanol ethanol, isopropanol, and methanol), hydrocarbons (e.g., ethyl benzene, toluene, and xylene), halogenated organics (e.g., 1,1,1 trichloroethane, 1,1,2 trichloro-1,1,2 trifluoroethane, carbon tetrachloride, and methylene chloride), metal compounds (e.g., beryllium, cadmium, and lead), tributyl phosphate, and a flocculating agent (polyelectrolyte).

- **IDC 291, Dried Lab Waste Fluoride Sludge—**IDC 291 is practically the same as IDC 290.

- **IDC 292, Incinerator Sludge—**Incinerator sludge residues identified as IDC 292 were generated from the recovery incinerator in Building 771 and were collected by filtering the scrubber solution. This material is nonhomogeneous, consists primarily of diatomite filter bed, and ranges from a paste-like damp mass to a partially dried mass that may contain fines. IDC 292 may contain trace amounts of alcohols/glycols (e.g., butanol ethanol, isopropanol, and methanol), hydrocarbons (e.g., ethyl benzene, toluene, and xylene), halogenated organics (e.g., 1,1,1 trichloroethane, 1,1,2 trichloro-1,1,2 trifluoroethane, carbon tetrachloride, and methylene chloride), metal compounds (e.g., beryllium, cadmium, and lead), tributyl phosphate, and a flocculating agent (polyelectrolyte).

- **IDC 299, Miscellaneous Sludge—**Filter sludges in IDC 299 are insoluble residues from nitric acid dissolution in Building 771, residues from the analytical laboratories in Building 371, and insoluble residues from miscellaneous operations in other buildings handling plutonium. The residues under this IDC have been characterized as mixed residues.

- **IDC 332, Oily Sludge—**The materials in IDC 332 are residues generated from routine maintenance of production equipment in Buildings 776 and 777. These residues are described as oily sludges resulting from routine equipment maintenance.

- **IDC 340, Sludge from Size Reduction Area—**Residue sludge from the size reduction area was generated in Building 776 in the size reduction vault. The size reduction vault operation recovered plutonium from non-Resource Conservation and Recovery Act–regulated metals and other materials, such as glovebox gloves. This material is nonhomogeneous and ranges from a paste-like damp mass to a partially dried powder that may contain fines.

Table B–27 shows the total bulk and plutonium concentrations for the sludge residues.

Table B–27 Sludge Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
089	Grease Oxide	1.3	0.3	1.3	0.3	1.0	100	100
099	Grease Fluoride	3.1	0.6	3.1	0.6	1.0	100	100
290	Filter Sludge	348	13.2	348	13.2	0.2	100	100
291	Dried Lab Waste Fluoride Sludge	18.9	0.88	18.9	0.88	0.2	100	100
292	Incinerator Sludge	7.9	0.56	7.9	0.56	0.2	100	100
299	Miscellaneous Sludge	151	7	102	7	0.2	67.9	>99
332	Oily Sludge	2.6	0.05	2.6	0.05	1.0	100	100
340	Sludge from Size Reduction Area	135	4.1	135	4.1	0.2	100	100

Pu = Plutonium STL = Safeguards Termination Limit

The number and types of packages for each IDC are given in **Table B–28**.

Table B–28 Number and Types of Packages of Sludge Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
089	Grease Oxide	0	6	0	6
099	Grease Fluoride	0	7	0	7
290	Filter Sludge	33	0	33	0
291	Dried Lab Waste Fluoride Sludge	2	0	2	0
292	Incinerator Sludge	1	3	1	3
299	Miscellaneous Sludge	9	21	8	18
332	Oily Sludge	1	0	1	0
340	Sludge from Size Reduction Area	9	0	9	0

STL = Safeguards Termination Limit

Table B-29 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDCs for Sludge Residues. Not all packages in each IDC have all the waste codes assigned.

Table B–29 Resource Conservation and Recovery Act Hazardous Waste Codes for Sludge Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
089	Grease Oxide	D007
099	Grease Fluoride	D007
290	Filter Sludge	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F005
292	Incinerator Sludge	D002, D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F003, F005
299	Miscellaneous Sludge	D002, D004, D005, D006, D007, D008, D009, D010, D011, D018, D019, D035, F002, F005
332	Oily Sludge	D007
340	Sludge from Size Reduction Area	D008

B.3.6 Filter Media Residues

See Attachment 1
Figures B–1, B–9, and B–10 show the sources and types of filter media generated at Rocky Flats.

Filter media residues are categorized as residue materials that have been wetted with liquids (e.g., acid, water, or organic solutions) in the normal course of processing plutonium-bearing materials. The sources of these residues are all the plutonium-processing buildings at Rocky Flats. The Item Description Codes (IDCs) included in this category are 331, 335, 338, 342, 376, and 490. They are described in the following paragraphs:

- **IDC 331, Filters, Ful Flo, Not From Incinerator—**Ful Flo filters were used for separating particulates from acid solution streams in plutonium recovery operations. These particulates contain insoluble plutonium imbedded in the filter media (polypropylene). Ful Flo filters also were used for separating particulates from machine coolant in fabrication operations; these particulates include plutonium metal particles. The filter media may be either polypropylene or cotton. IDC 331 was generated in Buildings 371, 707, 771, 776, 777, and 779. The Ful Flo filters were used to filter nitric acid and hydrochloric acid solution, caustic solution, solvent systems, water systems, and oil lubricating systems. The filters may contain small amounts of these liquids and may be contaminated with carbon tetrachloride, chromium, and Freon. This IDC can be a mixed or nonmixed residue.

- **IDC 335, Absolute Drybox Filters, Not Acid Contaminated—**High-efficiency particulate air filters (24'×24'×12') consist of a filter media of glass fibers and corrugated aluminum stiffeners. The filter media is held in place using an adhesive and sealant to a frame of fire retardant exterior grade plywood or wood particle board. Frames also consist of 14 U.S. gauge cadmium-plated or chromized carbon steel. Newer high-efficiency particulate air filters consist of glass and aromatic polyamide fibers and aluminum alloy stiffeners coated with a thermoset vinyl or epoxy. Small high-efficiency particulate air prefilters are used in ventilation systems in plutonium processing areas to filter out particulates from gloveboxes. These filters contain a glass fiber filter media and a wood frame. These prefilters are used at the glovebox for removing dust from the air exiting the glovebox. The sources of IDC 335 were Buildings 371, 374, 559, 707, 771, 774, 776, 779, and 881.

- **IDC 338, Filter Media—**IDC 338 is the filter media portion of the used filters, with the frame and the supporting stiffeners removed. It was generated in Buildings 371, 374, 559, 707, 771, and 776. This material can be wet or dry.

- **IDC 342, Absolute Drybox Filters, Acid Contaminated—**This IDC consists of High-efficiency particulate air filters used in filter plenums for removal of entrained particulates from air handling systems in all plutonium buildings. These filters are changed periodically when they become loaded with particulates or fail for other reasons. Although many of the filters are waste, some contain recoverable quantities of plutonium. These filters usually come from high dust operations where moisture, organics, or other nonacids also may collect; typically, they are contaminated with dilute nitric acid. These materials were generated in Buildings 559, 771, and 779.

- **IDC 376, Processed Filter Media—**This IDC is the same as IDC 338 but has been processed in an attempt to recover the embedded plutonium. IDC 376 is composed of the filter media portions of the used glovebox or High-efficiency particulate air filters that contain recoverable plutonium. Insoluble plutonium remains embedded in the media even after acid processing.

- **IDC 490, High-efficiency Particulate Air Filters, Not Acid Contaminated—**This IDC is the same as IDC 342, except that it is wet with liquids other than acids. These liquids may be water, caustic, or organics. This IDC was generated in Buildings 374, 771, 774, 776, and 777 and contains mixed and nonmixed residues.

Table B–30 shows the total bulk and plutonium concentrations for the filter media residues.

Table B–30 Filter Media Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
331	Filter, Ful Flo, Not from Incinerator	3,452	32.2	800	19.6	1.0	23.2	60.9
335	Absolute Drybox Filters, Not Acid Contaminated	275	2.7	73.0	1.33	1.0	26.5	49.3
338	Filter Media	2,297	92.5	1,705	90.6	1.0	74.2	98.0
342	Absolute Drybox Filters, Acid Contaminated	637	2.5	35	0.470	1.0	5.5	18.8
376	Processed Filter Media	868	2.3	0.423	0.074	1.0	0.05	3.2
490	HEPA Filters (24×24), Not Acid Contaminated	45.0	0.30	16.0	0.17	1.0	35.6	56.7

Pu = Plutonium STL = Safeguards Termination Limit HEPA = high-efficiency particulate air

The number and types of packages for each IDC are given in **Table B–31.**

Table B–31 Number and Types of Packages of Filter Media Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
331	Filter, Ful Flo	192	2	74	1
335	Drybox Filters	17	0	6	0
338	Filter Media	203	7	195	6
342	Drybox Filters	29	0	4	0
376	Proc. Filter Media	33	1	1	1
490	HEPA Filters	2	0	1	0

STL = Safeguards Termination Limit HEPA = high-efficiency particulate air
Note: Database did not provide a complete indication of container type. This EIS assumes that containers are drums unless specifically identified in the database as belonging in the "other" category.

Table B-32 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDCs for Filter Media Residues. Not all packages in each IDC have all the waste codes assigned.

Table B–32 Resource Conservation and Recovery Act Hazardous Waste Codes for Filter Media Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
331	Filter, Ful-Flo, from Incinerator	D002, F001, F002
338	Filter Media	D002, D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F003, F005, F006, F007, F009

B.3.7 Combustible Residues

See Attachment 1
Figure B–10 shows the sources and types of combustible residues generated at Rocky Flats.

Combustible residues consist of aqueous- and organic-contaminated combustibles and dry combustibles. The aqueous and organic combustible materials were wetted in the normal course of processing plutonium-bearing materials. Dry combustible materials are residues that have been staged for processing by incineration. Dry materials include paper, rags, cloth, plastics, personal protection equipment, latex gloves, and gaskets. The Item Description Codes (IDCs) within this category are 330, 336, 337, and 341. They are described in the following paragraphs:

- **IDC 330, Combustibles, Dry—**The materials in IDC 330 were generated in all plutonium processing buildings. These residues were generated during processing activities and maintenance and inventory operations. The residues include paper, rags, cloth, plastic, personal protective equipment, wood, personal protective equipment, and gaskets and may be contaminated with solvents. These materials have been segregated from liquids. The dry residues may be either mixed or nonmixed residues.

- **IDC 336, Combustibles, Wet—**IDC 336 is composed of combustible materials such as cloth, paper, rags, coveralls, rubber, wood, and other miscellaneous materials; it may contain small amounts of liquid. This material was generated mainly from cleanup activities in gloveboxes in Buildings 371, 374, 559, 707, 771, 774, 776, 777, and 779 in plutonium operations.

- **IDC 337, Plastics—**The materials in IDC 337 residues were generated in all plutonium processing buildings. These IDC residues are composed of plastics (e.g., Teflon, Kynar, polyvinyl chloride, polyethylene) used in various plutonium processes in routine production, cleanup, and inventory operations.

- **IDC 341, Leaded Drybox Gloves, Acid Contaminated—**Gloves are fabricated with three layers: a neoprene layer, a lead oxide layer, and a Hypalon layer. The surface of the glove exposed to the glovebox atmosphere (the Hypalon layer) is contaminated with plutonium and acids, bases, solvents, or oils from processing operations. IDC 341 materials are leaded drybox gloves that have been used as part of the personnel barrier in plutonium operations. Leaded gloves are used where gamma exposures are high from americium concentrations and additional personnel protection is required. These materials are acid contaminated and were generated in every residue building.

Table B–33 shows the total bulk and plutonium concentrations for the combustible residues.

Table B–33 Combustible Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
330	Combustibles, Dry	5,037	23.3	398	6.24	1.0	7.9	26.8
336	Combustibles, Wet	7,194	32.7	664	11.6	1.0	9.2	35.5
337	Plastics (e.g., Teflon, polyvinyl chloride, polyethylene)	1,542	6.4	57.4	3.23	1.0	3.7	50.5
341	Leaded Drybox Gloves, Acid Contaminated	477	1.4	21.0	0.270	1.0	4.4	19.3

Pu = Plutonium STL = Safeguards Termination Limit

The number and types of packages for each IDC are given in **Table B–34**.

Table B–34 Number and Types of Packages of Combustible Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
330	Combustibles, Dry	174	0	23	0
336	Combustibles, wet	311	0	38	0
337	Plastic (e.g., Teflon, polyvinyl chloride, polyethylene)	51	0	8	0
341	Leaded Drybox Gloves	8	0	1	0

STL = Safeguards Termination Limit

Table B-35 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDCs for Combustible Residues. Not all packages in each IDC have all the waste codes assigned.

Table B–35 Resource Conservation and Recovery Act Hazardous Waste Codes for Combustible Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
330	Combustible, Dry	F001, F002, F005
336	Combustibles, Wet	D001, D002, D008, F001, F002

341	Leaded Drybox Gloves	D003, D008

B.3.8 Glass Residues

The glass residues are materials consisting of ordinary glass, ceramics, leaded glass, and boron-impregnated Raschig rings originating from most plutonium buildings. The Item Description Codes (IDCs) in this category include 440, 441, and 442. They are described in the following paragraphs:

See Attachment 1
Figure B–11 shows the sources and types of glass residues generated at Rocky Flats.

- **IDC 440, Glass (Except Raschig Rings)—**Glass residues that make up IDC 440 were generated mainly in Buildings 371, 559, 771, and 779. These residues consist of ceramics and glassware in irregularly shaped pieces. The glass residues in this IDC are characterized as nonmixed residues.

- **IDC 441, Unleached Raschig Rings—**Raschig ring residues under IDC 441 originated from the Process Vent Scrubber System in Building 371 and in production tanks used for processing plutonium solutions in Building 771. Other buildings also may contribute to the Raschig ring residue inventory. Raschig rings are hollow borosilicate glass cylinders, 1-1/2" long by 1-1/2" in diameter by 3/16" thick, used to absorb neutrons and thus prevent criticality in large process tanks. These rings are homogeneous and are coated with insoluble plutonium compounds.

- **IDC 442, Leached Raschig Rings—**IDC 442 residues are Raschig rings. These rings are the same as IDC 441 but have been leached in an attempt to remove solid insoluble plutonium residues from the ring surfaces.

Table B–36 shows the total bulk and plutonium concentrations for the glass residues.

Table B–36 Glass Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
440	Glass (Except Raschig Rings)	1,334	7.0	116	3.20	1.0	8.7	45.7
441	Unleached Raschig Rings	117	1.11	7.29	0.948	1.0	6.2	85.4
442	Leached Raschig Rings	474	1.9	10.9	0.917	2.0	2.3	48.0

Pu = Plutonium STL = Safeguards Termination Limit

The number and types of packages for each IDC are given in **Table B–37**.

Table B–37 Number and Types of Packages of Glass Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
440	Glass (Except Raschig Rings)	40	1	8	0
441	Unleached Raschig Rings	5	3	1	0
442	Leached Raschig Rings	11	0	1	0

STL = Safeguards Termination Limit

Table B-38 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDC for Glass Residues. Not all packages in the IDC have all the waste codes assigned.

Table B–38 Resource Conservation and Recovery Act Hazardous Waste Codes for Glass Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
440	Glass (except Raschig Rings)	D005, D008

B.3.9 Graphite Residues

Graphite residues are materials consisting of graphite materials generated during plutonium foundry operations in Buildings 776 and 707 and firebrick material removed during maintenance operations on the residue recovery incinerator in Buildings 771 and 371. The Item Description Codes (IDCs) in this category include 300, 303, 312, and 377. They are described in the following paragraphs:

See Attachment 1
Figures B–1, B–2, and B–12 show the sources and types of graphite residues generated at Rocky Flats.

- **IDC 300, Graphite Molds—**The material in IDC 300 was generated in Buildings 707 and 776 (before 1969) after the cast product was removed from the graphite mold in plutonium foundry operations. These residues consist of large graphite pieces and were packaged for scarfing. The surfaces usually are coated with calcium fluoride to act as a barrier to prevent molten plutonium metal from reacting with the graphite. Plutonium, calcium, or magnesium metals may be present on the coated mold surface.

- **IDC 303, Scarfed Graphite Chunks, and IDC 312, Graphite, Coarse—**The materials in IDC 303 and IDC 312 residues were generated in Buildings 371, 707, 771, and 777. These residues are the coarse graphite material resulting from the scarfing operations from IDC 300. They consist of various oddly sized chunks of graphite mold containing some calcium fluoride mold coating and contaminated with plutonium metal and plutonium metal oxide. These residues are characterized as nonmixed residues.

- **IDC 377, Firebrick, Coarse—**The materials in IDC 377 consist of chunks of unpulverized firebrick material and were generated in Building 371 during incinerator stripout operations and in Building 771 during maintenance operations of the residue recovery incinerator. These materials consist of bricks and chunks of bricks resulting from the scarfing process to remove plutonium from the surface of the firebricks. The firebrick is composed of high-density alumina ceramic firebrick material and is coated with a glaze containing plutonium and americium formed during the incineration process. Residues from IDC 377 are characterized as mixed residues.

Table B–39 shows the total bulk and plutonium concentrations for the graphite residues.

Table B–39 Graphite Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of this IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
300	Graphite Molds	8,525	12	90.7	2.52	1.0	1.1	21.0
303	Scarfed Graphite Molds	468	0.72	5.85	0.477	1.0	1.3	66.3

312	Graphite, Coarse	2,273	95.3	1,779	93.0	1.0	78.3	97.6
377	Firebrick, Coarse	2,800	19.0	3.28	1.41	5.0	0.1	7.4

Pu = Plutonium STL = Safeguards Termination Limit

The number and types of packages for each IDC are given in **Table B–40**.

Table B–40 Number and Types of Packages of Graphite Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
300	Graphite Molds	125	13	6	12
303	Scarfed Graphite Molds	6	0	1	0
312	Graphite, Coarse	116	27	99	25
377	Firebrick, Coarse	38	4	0	2

STL = Safeguards Termination Limit

Table B-41 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDCs for Graphite Residues. Not all packages in each IDC have all the waste codes assigned.

Table B–41 Resource Conservation and Recovery Act Hazardous Waste Codes for Graphite Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
300	Graphite Molds	F001
377	Firebrick, Coarse	D004, D005, D006, D007, D008, D009, D010, D011, F001, F002, F003, F005

B.3.10 Inorganic (Metals and Others) Residues

Inorganic residues are materials consisting of various metals, crucibles, and insulation generated in production, maintenance, and construction operations. The Item Description Codes (IDCs) included in this category are 197, 320, 360, 370, 438, and 480. IDCs in this category are described in the following paragraphs:

See Attachment 1
Figures B–4, B–5, B–6, B–8, and B–12 show the sources and types of inorganic residues generated at Rocky Flats.

- **IDC 197, Tantalum Target and Sub-Target, To Be Leached—**The materials in IDC 197 are metal targets, tantalum equipment, and other miscellaneous metals used during production operations in Buildings 707 and 777. These metal components were reused in plutonium operations until they reached failure or end of life. Plutonium penetrates the metal surfaces during these operations. These residues are characterized as nonhazardous.

- **IDC 320, Heavy Non-Special Source Metal (Tantalum, Tungsten, Platinum)—**The materials in IDC 320 were generated in various processes in Buildings 371, 707, 771, 776, and 779 for periodic replacement of the original equipment. This IDC is considered homogeneous except for the surface layer of plutonium. The materials are in the form of tantalum, tungsten, and platinum equipment (e.g., vessels, pans, and rods) that was contaminated with plutonium on the surface. Some materials are corroded or coated with pyrochemical salts as well as plutonium metal and oxide. This IDC residue can be mixed or nonmixed.

- **IDC 360, Aluminum Oxide Crucible—**Aluminum oxide crucibles were used to contain the molten chloride salts used in pyrochemical processing and in pyrochemical development work in Buildings 771, 776, and 779. Typically, after cooling to room temperature, the crucible would be broken and its contents removed. The broken crucible pieces are identified as IDC 360 and consist of irregularly shaped pieces of aluminum oxide coated with pyrochemical salts (and, possibly, such reactive metals as calcium, magnesium, and plutonium).

- **IDC 370, LECO Crucible—**The material in IDC 370 was generated in the analytical laboratories of Buildings 559 and 771. LECO crucibles were used for carbon analyses of plutonium metals and oxides and for calibration purposes. The LECO crucible consists of aluminum silicate-based ceramic with approximately 0.5 percent chromium. IDC 370 will have plutonium oxide fused onto the crucible along with an accelerator, such as tin.

- **IDC 438, Insulation—**The material in IDC 438 is insulation composed of aluminum oxide and silicon dioxide generated during maintenance, strip-out, and repair operations. Other waste that may be included in this IDC includes sweepings from insulation work cleanup.

- **IDC 480, Light Metal—**The material in IDC 480 was generated in all plutonium processing buildings and consists of stainless steel, aluminum, copper, iron, brass, galvanized metal, mild steel, and other common metals. These residues include tools, piping, cables, and valves generated during maintenance and construction operations.

Table B–42 shows the total bulk and plutonium concentrations for the inorganic residues.

Table B–42 Inorganic Residues That Are Evaluated in this EIS

IDC	*Residue*	*Kg of Total Bulk of IDC*	*Kg of Pu in Total Bulk*	*Kg Bulk Requiring Processing*	*Kg of Pu in Bulk Requiring Processing*	*STL Pu Weight %*	*Bulk % > STL*	*Pu % > STL*
197	Tantalum Target and Sub-Target, to be Leached	113	1.37	113	1.37	0.2	100	100
320	Heavy Non-Special Source Metal (Tantalum, Tungsten, Platinum)	2,550	15.5	237	4.59	1.0	9.3	29.6
360	Aluminum Oxide Ceramic Crucible	42.1	0.2	20.5	0.1	0.2	48.7	50.0
370	LECO Crucible	8,223	137	19.7	7.46	5.0	0.24	5.4
438	Insulation	26.8	0.082	26.8	0.082	0.2	100	100
480	Light Metal	4,311	11.2	46.1	4.08	1.0	1.1	36.4

Pu = Plutonium STL = Safeguards Termination Limit

The number and types of packages for the IDC are given in **Table B–43**.

Table B–43 Number and Types of Packages of Inorganic Residues

IDC	*Description*	*55-Gallon Drums (Total)*	*Other (Total)*	*55-Gallon Drums (Above STL)*	*Other (Above STL)*
197 [a]	Tantalum Target and Sub-Target, to be Leached	0	22	0	22
320	Heavy Non-Special Source Metal (Tantalum, Tungsten, Platinum)	54	4	9	1
360	Aluminum Oxide Ceramic Crucible	3	0	1	0
370	LECO Crucible	160	0	8	0
438	Insulation	2	0	2	0
480	Light Metal	76	41	2	40

STL = Safeguards Termination Limit

[a] Packaging type was not indicated in the Rocky Flats Database; therefore, the packaging type is placed under the category of "Other" rather than "55-Gallon Drums."

Table B-44 provides the Resource Conservation and Recovery Act hazardous waste codes associated with the applicable IDC for Inorganic Residues Not all packages in each IDC have all the waste codes assigned.

Table B–44 Resource Conservation and Recovery Act Hazardous Waste Codes for Inorganic Residues

IDC	*Description*	*Resource Conservation and Recovery Act Codes*
320	Heavy Non-Special Source Metal (Tantalum, Tungsten, Platinum)	D008

B.3.11 Scrub Alloy

See Attachment 1
Figures B–4 and B–5 show the sources and types of scrub alloy generated at Rocky Flats.

The scrub alloy category includes approximately 700 kg (1,540 lb) of material containing approximately 200 kg (440 lb) of plutonium. The scrub alloy is a distinct category of plutonium-bearing material. Scrub alloy is a mixture of magnesium, aluminum, americium, and plutonium alloy generated during the salt scrub processing of molten salt extraction salts and the anode alloy processing of electrorefining anode heels. Scrub alloy consists of Item Description Codes (IDCs) 025, 600, 602, 603, 604, and 620. These IDCs were grouped together because of their chemical likeness or the similar way in which they will be processed and repackaged. The entire total scrub alloy inventory will require processing to put it in a form suitable for disposition. Safeguards Termination Limits do not apply to scrub alloy.

The primary hazard associated with scrub alloys is worker exposure from gamma radiation. The radiation hazard is caused by the presence of americium, which is 50 times more radioactive than plutonium. Americium also emits low energy gamma radiation, which is very intense if not adequately shielded. The high americium content provides approximately 1 rem/hour dose rate from the surface of the scrub alloy. Current packaging of the scrub alloys was not intended for long-term storage. IDCs in this category are described in the following paragraphs:

- **IDC 025, Aluminum Alloy Anode Heel for Savannah River Site, and IDC 620, Aluminum Alloy Buttons—**IDCs 025 and 620 are metal alloys generated when anode heel from electrorefining was alloyed with aluminum to generate a scrub alloy. IDC 025 has less americium and more other impurities than IDC 620. IDCs 025 and 620 are characterized as products for shipment to the Savannah River Site.

- **IDC 600, Molten Salt Extraction Scrub Alloy—**The material in IDC 600 is a metal alloy generated during the salt scrub process that strips plutonium and americium from the molten salt extraction salts using magnesium to reduce to plutonium metal and aluminum to alloy the metal. Sodium chloride, potassium chloride, and magnesium chloride salt matrix were the major molten salt extraction salt inputs to the salt scrub process. IDC 600 is characterized as a product for shipment to the Savannah River Site.

- **IDC 602, Calcium Chloride/Cesium Chloride Scrub Alloy—**The material in IDC 602 is a metal alloy generated since 1989, when the molten salt extraction production process was changed to use dicesium hexachloroplutonate as the extractant and calcium chloride as the diluent (see Section B.3.3.3 of this appendix). IDC 602 is characterized as a product for shipment to the Savannah River Site.

- **IDC 603, Cerium/Calcium Scrub Alloy—**The material in IDC 603 is a metal alloy generated since 1989, when calcium was the reductant and gallium was being investigated as an alloying agent. IDC 603 is characterized as a product for shipment to the Savannah River Site.

- **IDC 604, Gallium/Calcium Scrub Alloy—**The material in IDC 604 is a metal alloy generated since 1989, when calcium and cerium were being investigated as the alloying agents in the salt scrub process. IDC 604 is characterized as a product for shipment to the Savannah River Site.

Table B–45 shows the number of packages for IDCs 025, 600, 602, 603, 604, and 620.

Table B–45 Number of Packages of Scrub Alloy

IDC	*Description*	*Number of Items*
025	Aluminum Alloy Anode Heel for Savannah River Site	93
600	Molten Salt Extraction Scrub Alloy	146
602	Calcium Chloride/Cesium Chloride Scrub Alloy	4
603	Cerium/Calcium Scrub Alloy	6
604	Gallium/Calcium Scrub Alloy	23
620	Aluminum Alloy Buttons	4

B.4 REFERENCES

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ATTACHMENT 1: FLOW DIAGRAMS

The figures in this attachment are flow diagrams that show the sources and types of the various residues presented in Appendix B. The Item Description Codes given on the figures are described and tabulated in Appendix B.

List of Figures

Page

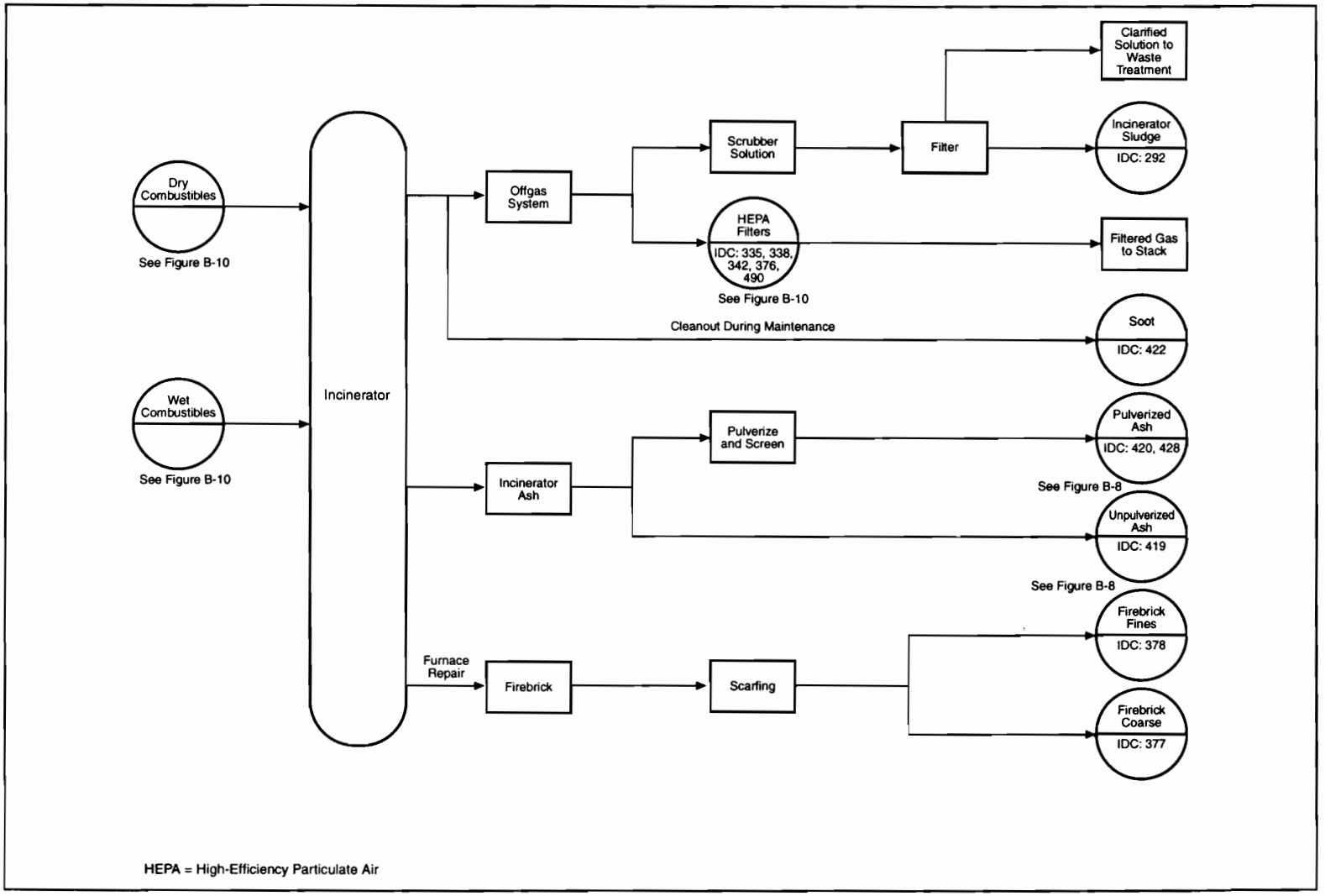


Figure B–1 Ash Residues—Building 771

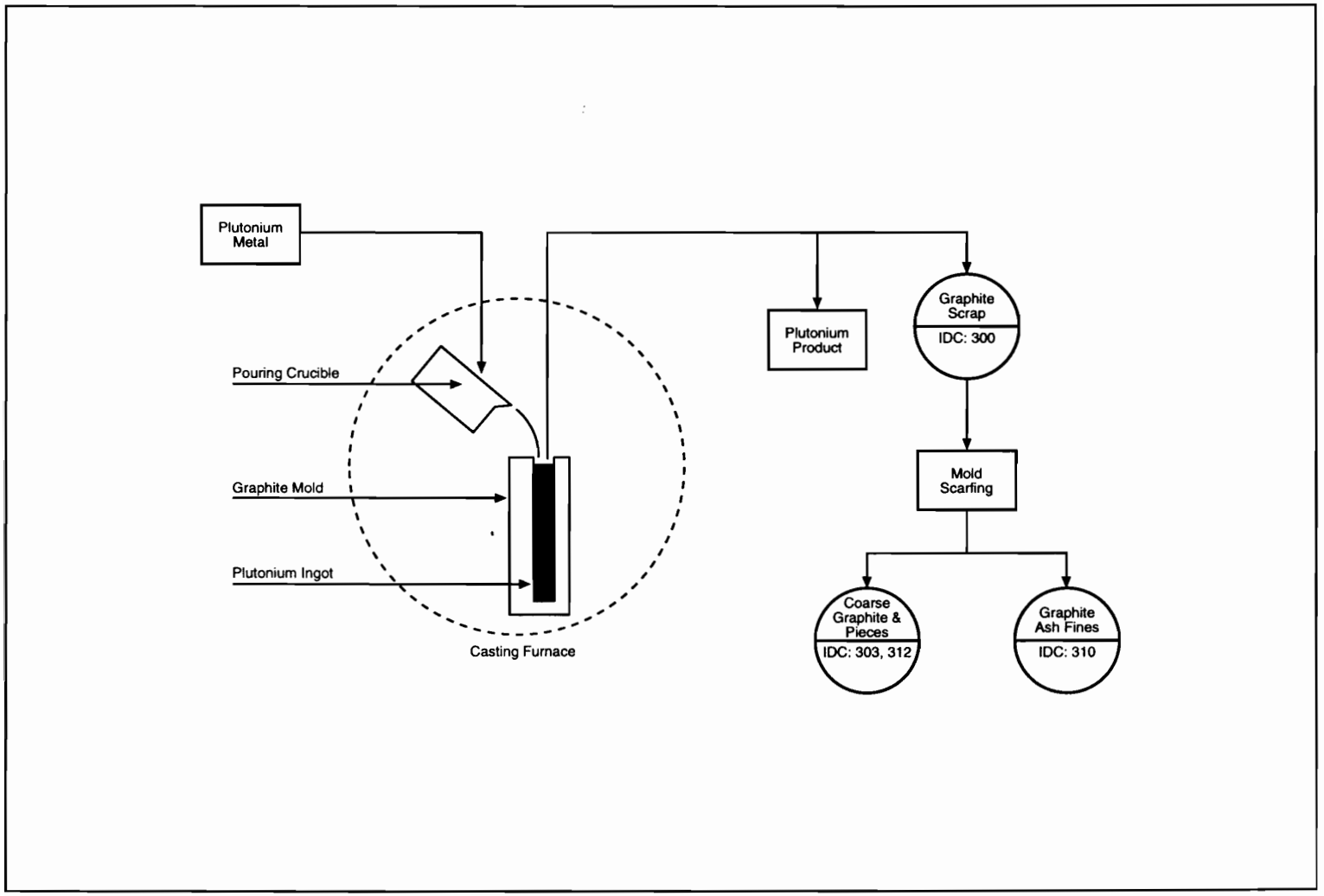


Figure B–2 Graphite and Graphite Ash Fines Residues—Buildings 371, 707, 771, and 777

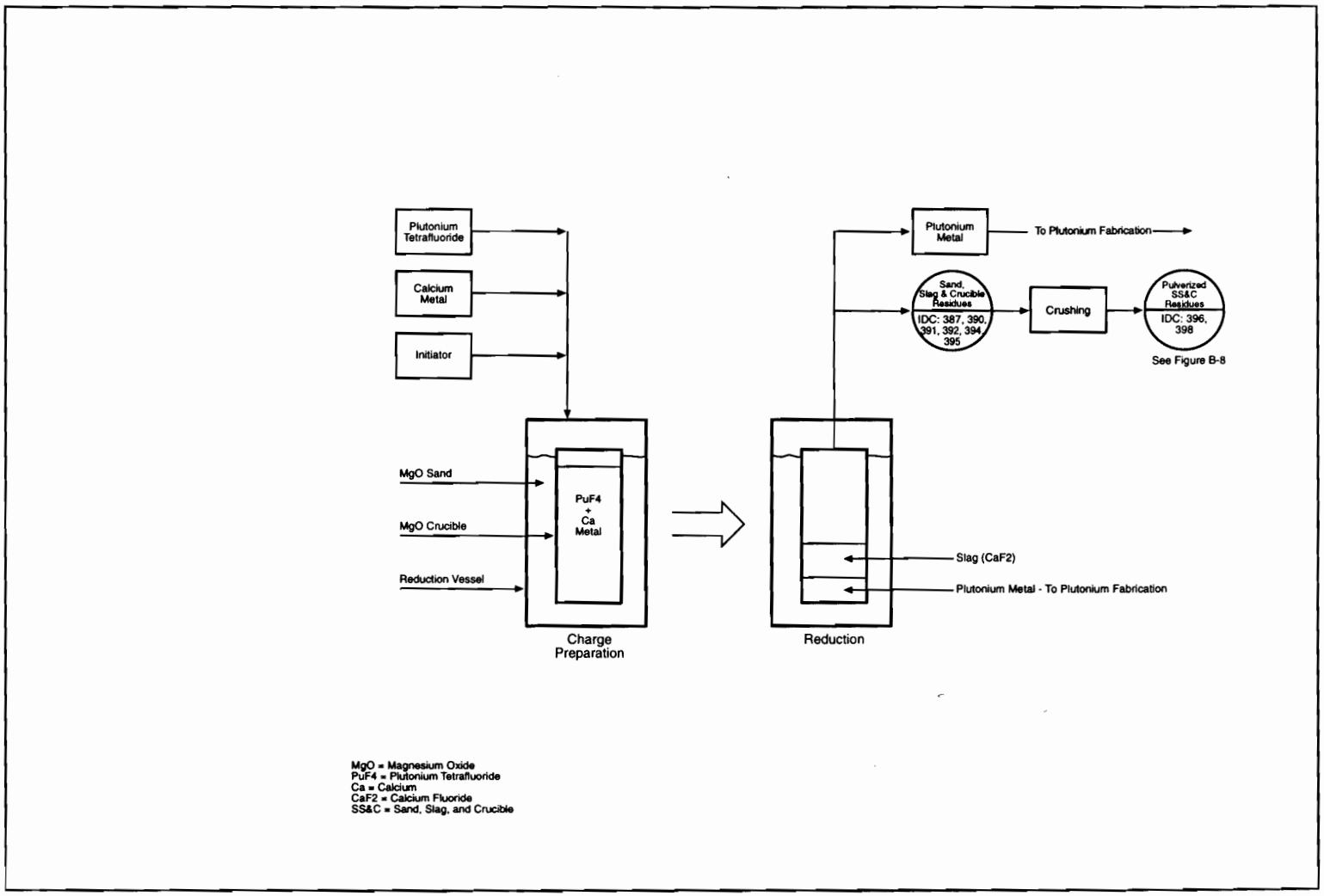


Figure B–3 Sand, Slag, and Crucible Residues—Buildings 371, 771, and 779

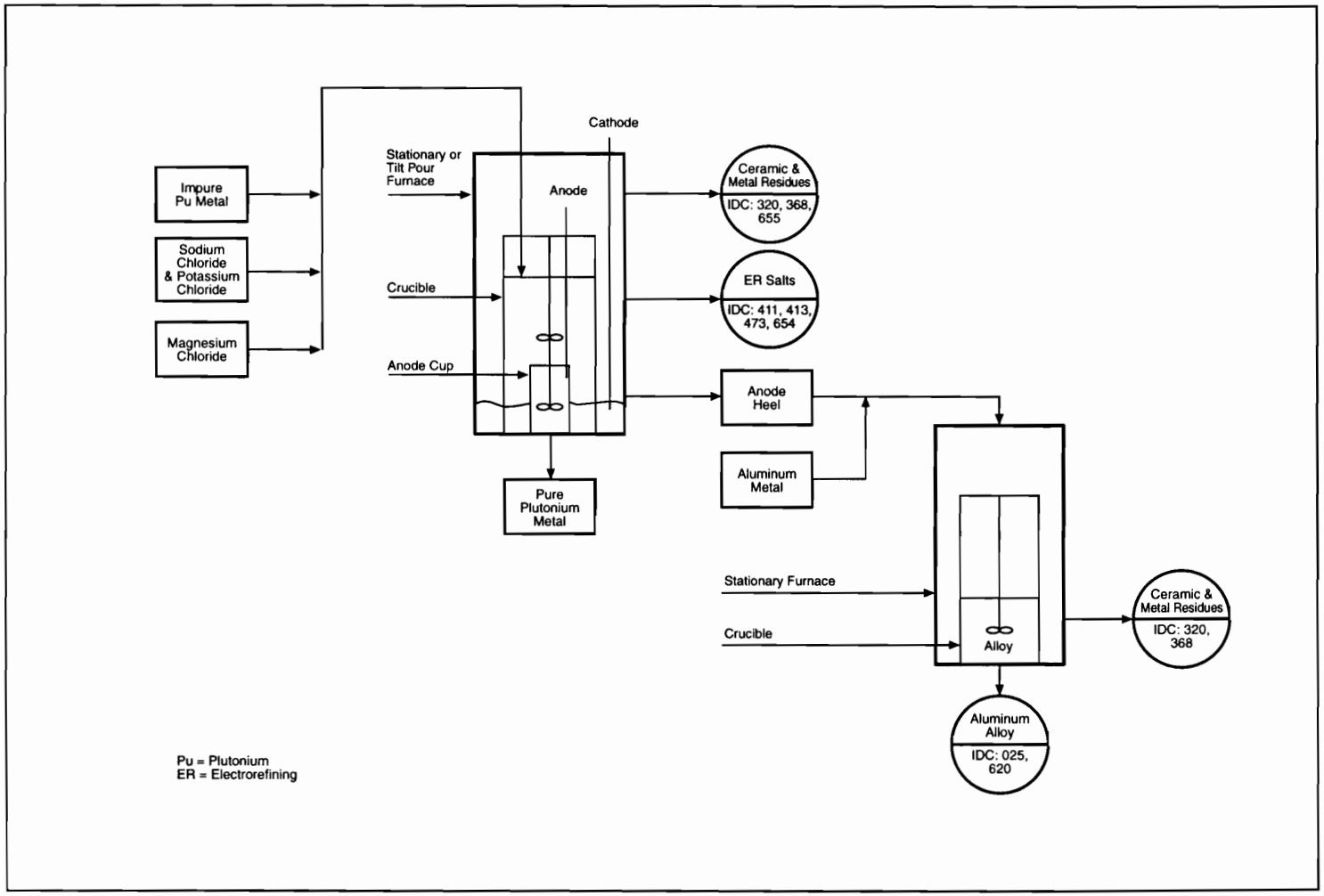


Figure B–4 Electrorefining Salt and Anode Alloy Process Residues—Buildings 371, 776, and 779

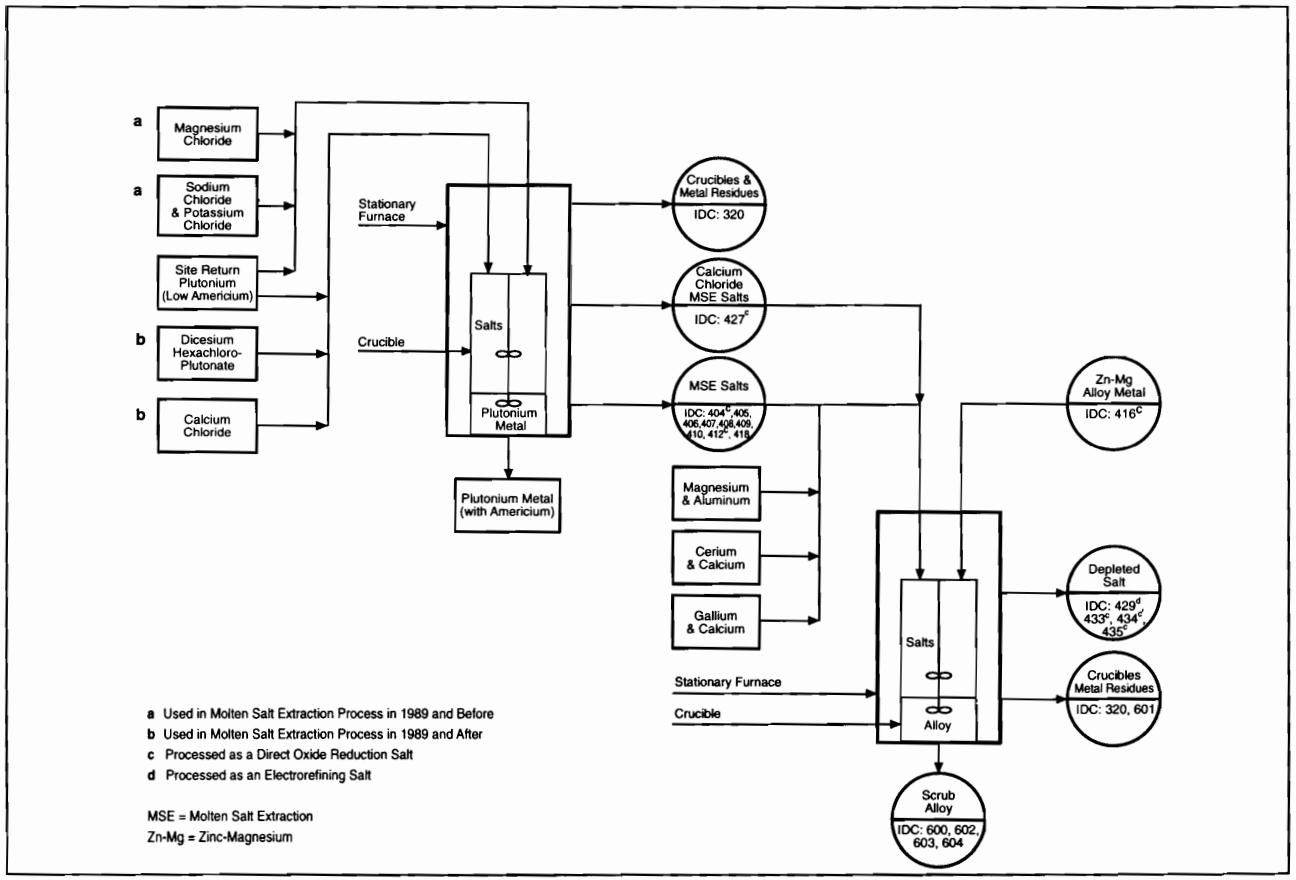
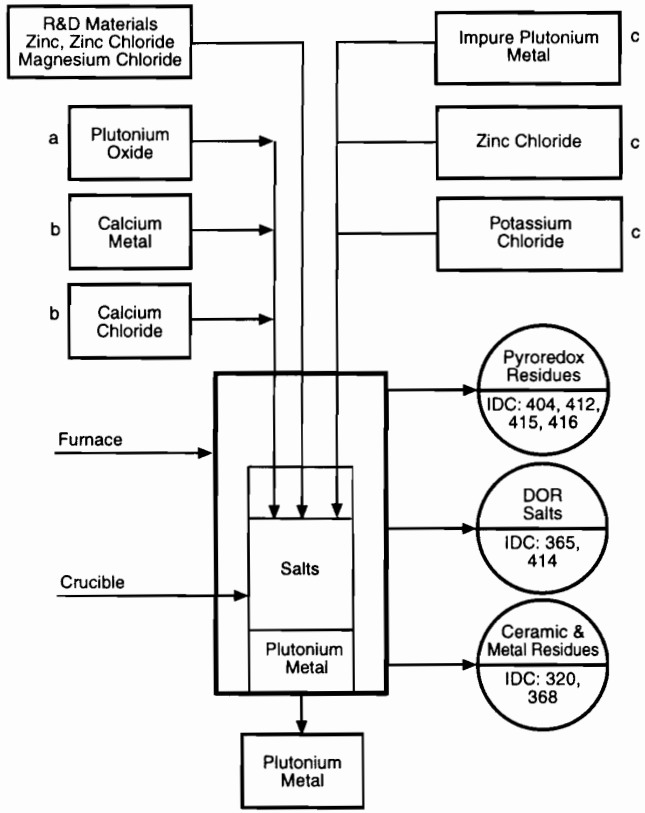


Figure B–5 Molten Salt Extraction Residues and Scrub Alloy—Buildings 776 and 779



a = Reagents in the Direct Oxide Reduction Process
b = Reagents common to both the Direct Oxide Reduction and Pyroredox Processes
c = Reagents in the Pyroredox Process

R&D = Research and Development
DOR = Direct Oxide Reduction

Figure B–6 Direct Oxide Reduction Residues—Buildings 776 and 779

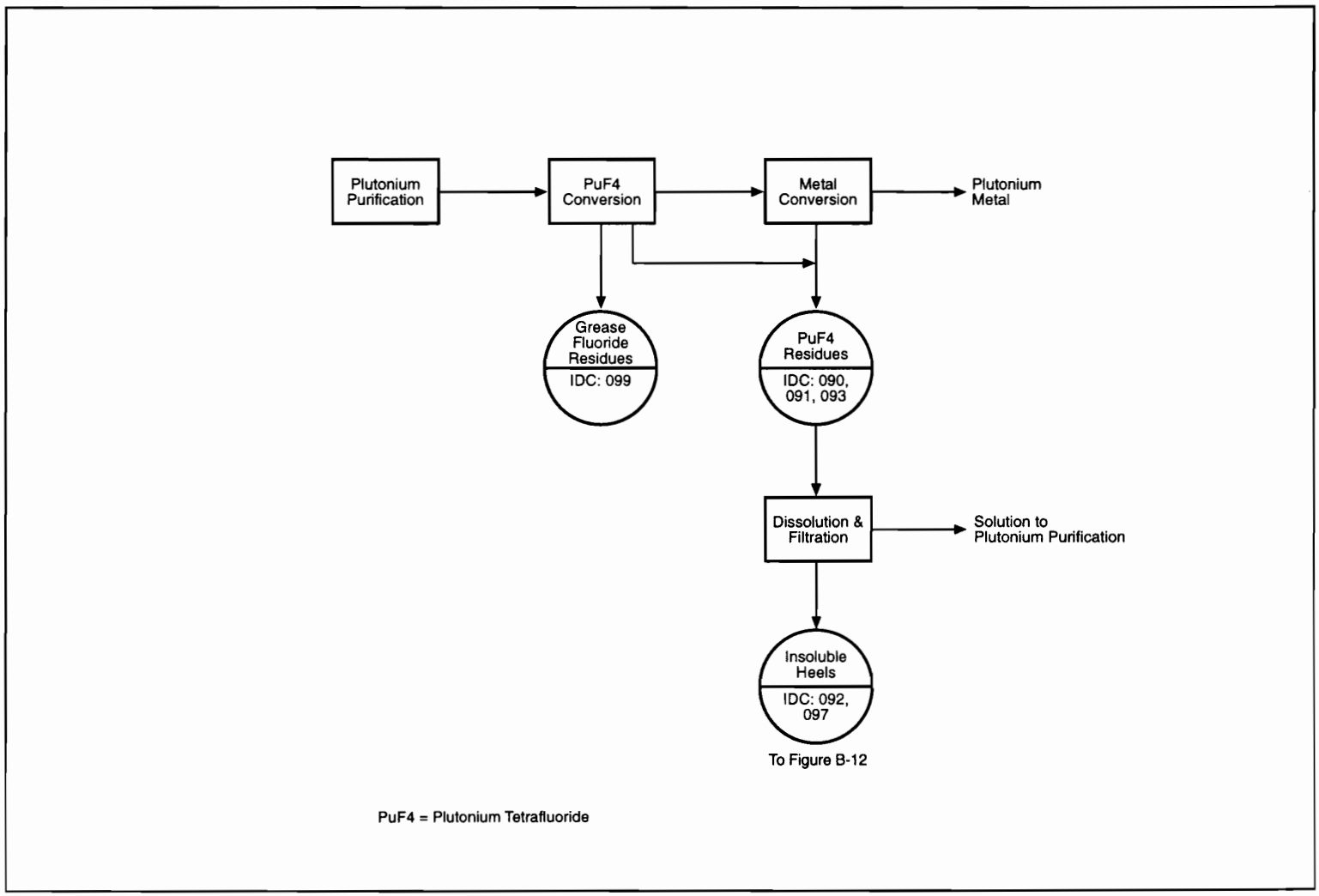


Figure B–7 Plutonium Fluoride Residues—Buildings 371 and 771

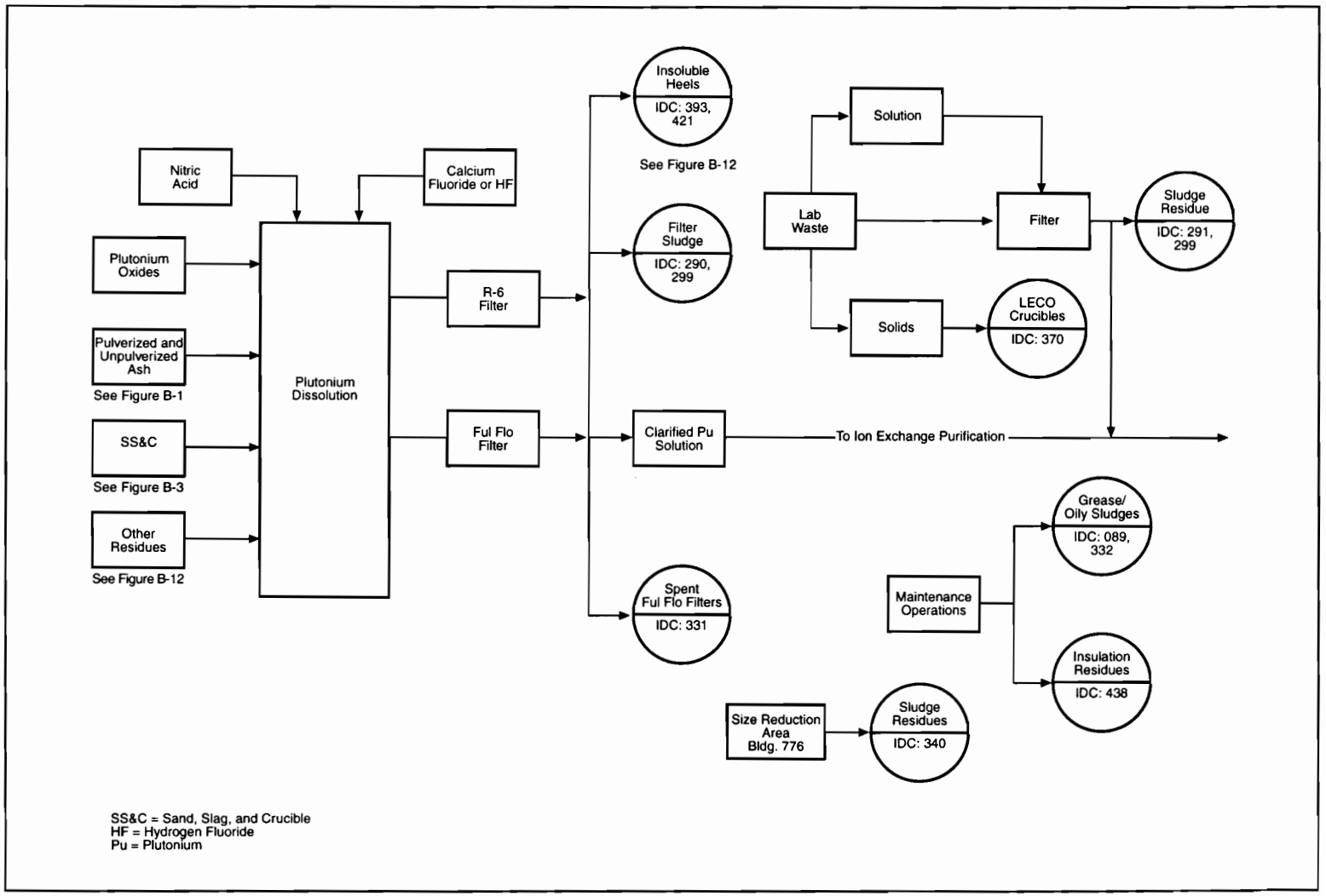


Figure B–8 Sludge Residues—Buildings 371, 559, and 771

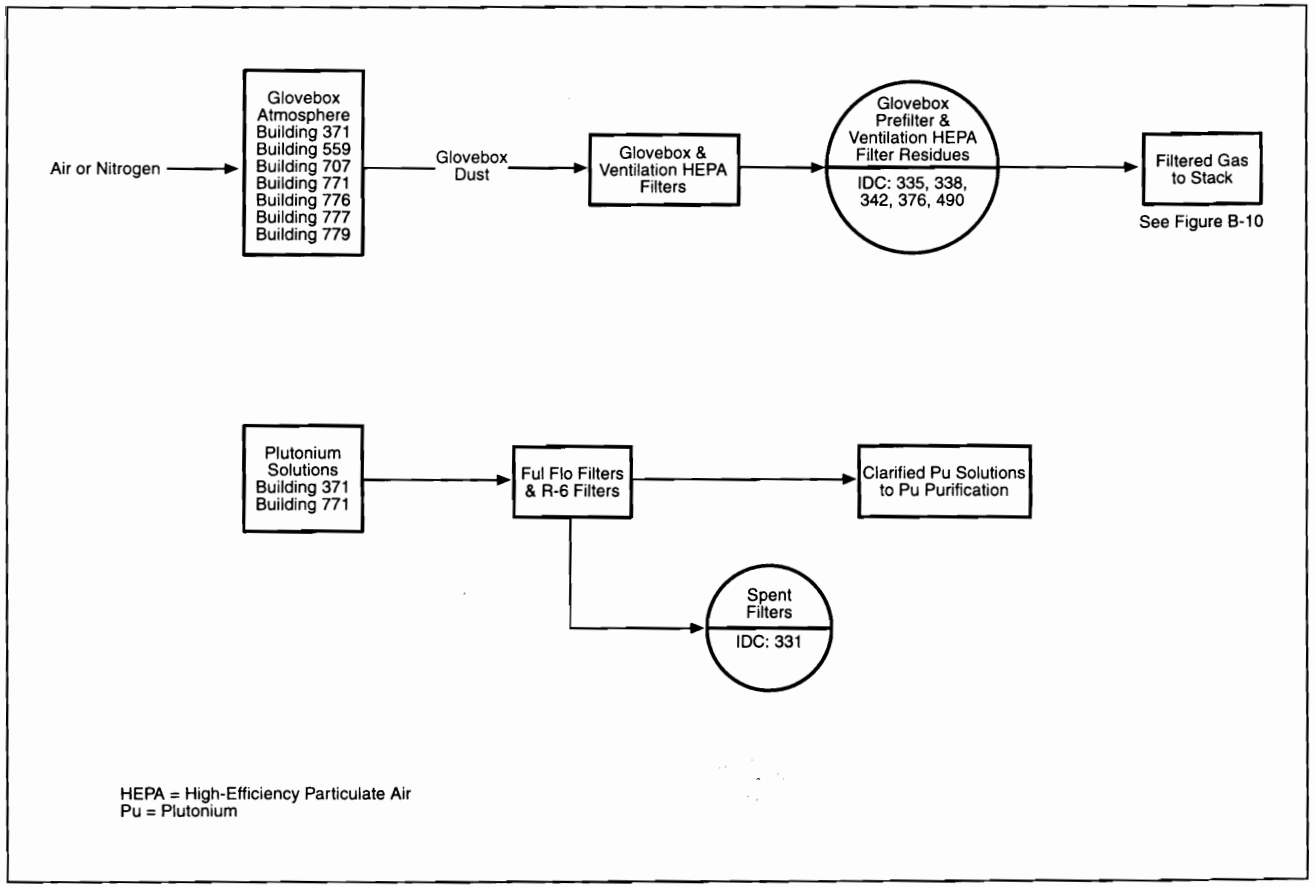


Figure B–9 Filter Residues

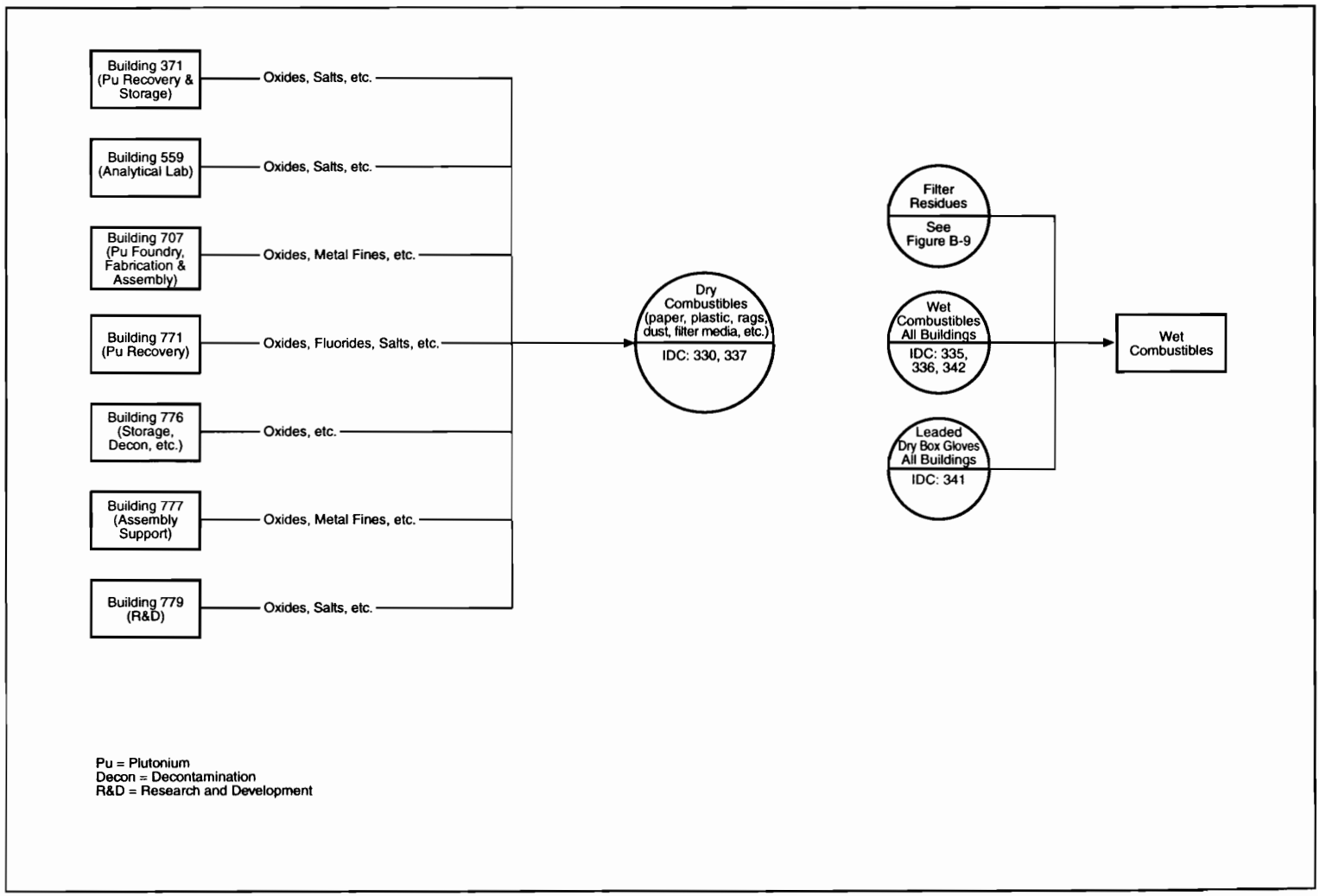


Figure B–10 Combustible Residues

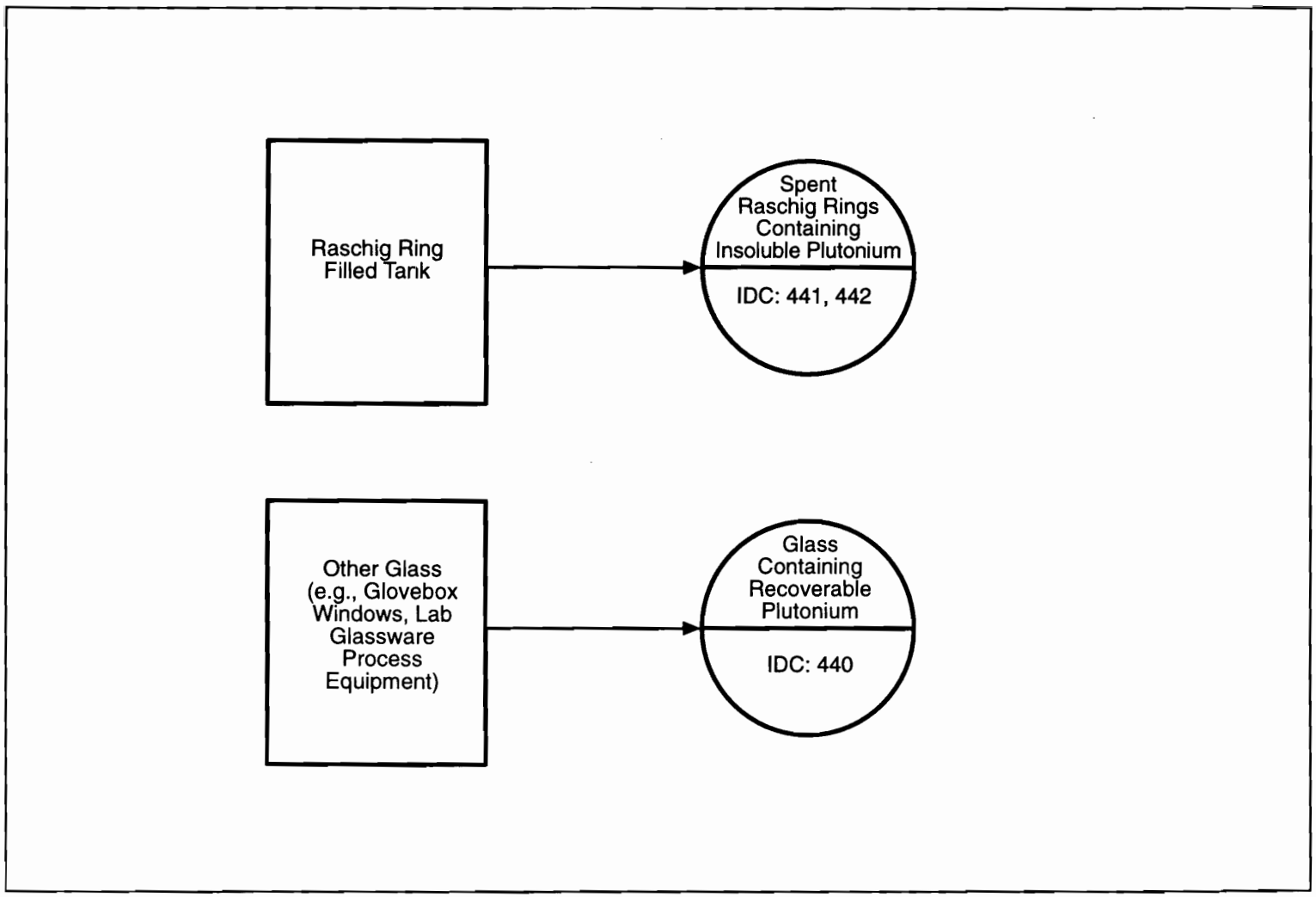


Figure B–11 Glass Residues

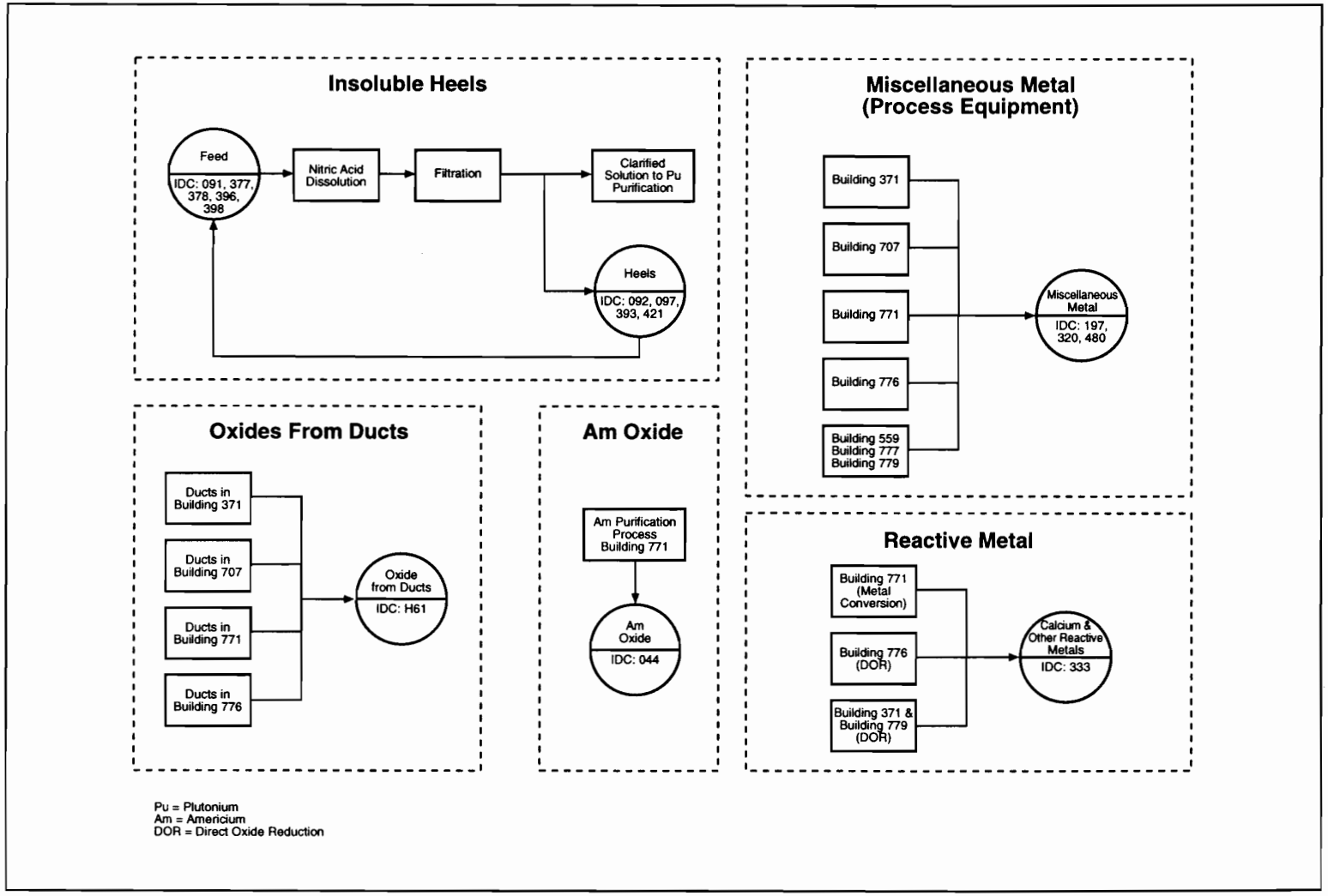


Figure B–12 Other Residues

APPENDIX C
DESCRIPTION OF PROCESSING TECHNOLOGIES

C.1 INTRODUCTION

This appendix presents detailed descriptions of the technologies evaluated in the Environmental Impact Statement (EIS) for the processing of certain plutonium residues and scrub alloy stored at the Rocky Flats Environmental Technology Site (Rocky Flats) so that they are brought into compliance with safeguards termination limits for ultimate disposition. The chronological development of the safeguards termination limits as a part of overall safeguards protection is presented in a series of memos and letters. The most relevant of these are included in Attachment 1 to this appendix. This appendix also describes the screening process and approach used to select and evaluate the most suitable processing technologies for these materials in the proposed action. Processing technologies discussed include those that do not remove plutonium from the material (e.g., immobilization technologies) and those that separate plutonium from the material (e.g., acid dissolution technologies). No Action Alternative processing technologies that were analyzed in the *Environmental Assessment, Finding of No Significant Impact, and Response to Comments-Solid Residue Treatment, Repackaging, and Storage* (DOE 1996d), or Solid Residue Environmental Assessment, are also presented in this appendix.

C.2 SCREENING AND EVALUATION APPROACH

The U.S. Department of Energy (DOE) used a screening process to identify a reasonable set of technologies for detailed evaluation in this EIS. In selecting these technologies, a number of factors were considered, including the following:

- Direct applicability of the technology to the particular material type
- Maturity and timing of the technology so that processing could be accomplished in the 1998-2004 time frame within reasonable cost
- Potential impact of processing technology implementation to ongoing mission activities at the site
- Experience of the DOE site in employing the technology and availability of facilities and equipment
- Minimization of the number of process steps to reduce worker exposures
- Amount of secondary wastes generated and appropriate secondary waste disposition methods.

The initial screening process began with the assessment of a wide range of potential processing technologies that were identified in the following DOE studies and during the public scoping process.

- **Trade Studies (DOE 1995, 1996a, 1996b, 1996e, 1996f, and 1997a)—**DOE conducted a series of trade studies to identify the best possible technologies for stabilizing plutonium residues to an end state suitable for disposition. The trade studies were developed by the DOE Nuclear Material Stabilization Task Group, which comprised representatives from the DOE sites that store plutonium residues or have capabilities in treating the residues, as well as DOE Headquarters and other interested individuals. The trade studies

resulted in a technical assessment of various approaches and a bounding of the range of alternative stabilization approaches for further consideration.

- **Environmental Assessment—**DOE prepared the Solid Residue Environmental Assessment (DOE 1996d) to address the environmental impacts associated with stabilizing the entire 106,600 kilogram (kg) (235,000 pound [lb]) inventory of Rocky Flats plutonium residues to allow for safe storage pending final disposition. This environmental assessment addressed stabilization technologies that would provide for safe storage. It did not address technologies for the further processing needed to comply with safeguards termination limits required for ultimate disposition because the environmental assessment was prepared before the safeguards termination limits were developed and implemented. The "no action" alternatives in this EIS are based on the technologies identified in the Solid Residue Environmental Assessment.

- **The Rocky Flats Residue Rebaselining Study—**Rocky Flats prepared a study entitled *Residue Rebaselining for Combustibles, Fluorides, Ash, and Miscellaneous Residues* (DOE 1997b) to identify the most viable options for removal of residues from the site. This study resulted in proposed paths and alternative technologies for preparing the residues for final disposition (i.e., to meet or exceed the safeguards termination limits).

- **Public Scoping Comments—**Public scoping comments were received by DOE during the November 1996 to January 1997 time frame and were considered during the screening process. Many of the comments included preferences for certain technology paths and locations for stabilization.

After the initial screening process, DOE Headquarters requested the candidate processing sites (Rocky Flats, the Savannah River Site, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory) to assess the technologies identified in the initial screening process from a site-specific perspective, considering the screening and evaluation factors described previously. Each site provided input on which technologies could be implemented at their site, taking into account their respective capabilities, facilities, and equipment. Working sessions were held between DOE candidate site and Headquarters representatives to review the benefits and constraints of processing technologies at each site and to reach consensus on the sites and technologies that should to be evaluated in this EIS.

The technologies described herein were determined to be technologically mature enough to be considered as viable options for stabilization of the various residue materials at Rocky Flats.

A further discussion of the screening process is given in Sections 2.3 and 2.9 of this EIS.

C.3 PROCESSING TECHNOLOGIES FOR ROCKY FLATS PLUTONIUM RESIDUES AND SCRUB ALLOY

The following sections give detailed descriptions of the candidate processing technologies for each of the material categories discussed in Appendix B of this EIS. The proposed technologies are presented by material category in **Table C–1**. Each material has a No Action processing technology–Alternative 1 (Section C.4), a processing technology without plutonium separation–Alternative 2 (Section C.5), and a processing technology with plutonium separation –Alternative 3 (Section C.6). In addition, DOE has combined certain elements of Alternatives 1 and 2, with the application of a variance to safeguards termination limits, for the residues to form an Alternative 4.

Table C–1 Candidate Process Technologies by Material Category

Material Category	*No Action Stabilization*	*Processing without Plutonium Separation*	*Processing with Plutonium Separation*	*Combination of Processing Technologies*
Ash Residues				
Incinerator Ash	Calcination and cementation	Calcination and vitrification	Purex with ash fusion preprocessing	Calcination/Cementation Repackaging
		Blend down	Mediated electro-chemical oxidation with preprocessing	
		Cold Ceramification		
Sand, Slag, and Crucible	Calcination and cementation	Vitrification	Purex with preprocessing	Calcination/Cementation Repackaging
		Blend Down		
Graphite Fines	Calcination and cementation	Vitrification	Mediated electrochemical oxidation with preprocessing	Calcination/Cementation Repackaging
		Blend Down		
		Cold Ceramification		
Inorganic	Calcination and cementation	Vitrification		Calcination/Cementation Repackaging
		Blend Down		
		Cold Ceramification		
Salts Residues				
Electrorefining Salts	Pyro-oxidation	Pyro-oxidation and blend down	Pyro-oxidation and salt distillation	Repackaging
			Pyro-oxidation and water leach with plutonium oxide recovery	
			Salt Scrub with Purex processing of newly created alloy	
Molten Salt Extraction	Pyro-oxidation	Pyro-oxidation and blend down	Pyro-oxidation and salt distillation	Repackaging
			Pyro-oxidation and water leach with plutonium oxide recovery	
			Salt scrub with Purex processing of newly created scrub alloy	
Direct Oxide Reduction	Pyro-oxidation	Pyro-oxidation and blend down	Water leach with plutonium oxide recovery	Repackaging
			Acid dissolution with plutonium oxide recovery	
			Salt scrub with Purex processing of newly created alloy	
Combustible Residues				
Aqueous-contaminated	Neutralization and drying	Sonic wash Catalytic chemical oxidation	Mediated electrochemical oxidation	Neutralize/Dry
Organic-contaminated	Thermal desorption and steam passivation	Blend down		Thermal Desorption/Steam Passivation
Dry	Repackaging			Repackaging

Material Category	*No Action Stabilization*	*Processing without Plutonium Separation*	*Processing with Plutonium Separation*	*Combination of Processing Technologies*
Plutonium Fluoride Residues	Acid dissolution with plutonium oxide recovery	Blend down	Acid dissolution with plutonium oxide recovery Purex with plutonium metal or oxide recovery	Does not apply
Filter Media Residues	Neutralization	Vitrification (HEPA filters only) Blend down (HEPA filters only) Sonic wash	Mediated electro-chemical oxidation	Neutralize/Dry (IDC 338 only) Repackaging (All Other Filter Media)
Sludge Residues	Filtration and drying	Vitrification Blend down	Acid dissolution with plutonium oxide recovery (except IDCs 089, 099, and 332)	Filter/Dry (Except IDCs 089, 099, and 332) Repackage (IDCs 089, 099, and 332)
Glass Residues	Neutralization and drying	Vitrification Blend down Sonic wash	Mediated electrochemical oxidation	Neutralize/Dry
Graphite Residues	Repackaging	Cementation Vitrification Blend down	Mediated electrochemical oxidation	Repackaging
Inorganic (Metal and Other) Residues	Repackaging	Vitrification Blend down	Mediated electrochemical oxidation	Repackaging
Scrub Alloy	Repackaging	Vitrification	Purex with plutonium metal or oxide recovery	Does not apply

HEPA = high-efficiency particulate air

The technology descriptions consist of a summary of the technology process; flow chart diagrams; and a description of each process step. The proposed technologies are as follows:

❒ **No Action Processing Technologies**

- Calcination and cementation of ash residues
- Pyro-oxidation of pyrochemical salts
- Neutralization and drying of aqueous-contaminated combustibles
- Thermal desorption and steam passivation of organic-contaminated combustibles
- Repackaging of dry combustibles
- Acid dissolution and plutonium oxide recovery of plutonium fluorides
- Neutralization of filter media
- Filtration and drying of sludge residues
- Neutralization and drying of glass residues
- Repackaging of graphite residues, inorganic residues, and scrub alloy.

❒ **Technologies without Plutonium Separation**

- Immobilization (vitrification)
- Immobilization (cementation)
- Blend down

- Pyro-oxidation and blend down of pyrochemical salts
- Sonic wash
- Catalytic chemical oxidation of combustibles
- Cold ceramification.

❒ **Processing Technologies with Plutonium Separation**

- Purex process with plutonium metal or oxide recovery
- Mediated electrochemical oxidation
- Salt distillation
- Water leach with plutonium oxide recovery
- Salt scrub with Purex processing of newly created scrub alloy
- Acid dissolution with plutonium oxide recovery.

❒ **Combination of Processing Technologies**

(In addition to these processes, materials may also be blended with low plutonium concentration materials or inert materials to achieve a 10 percent plutonium concentration and a variance to safeguards termination limits would be applied.)

- Calcination/Cementation
- Repackaging
- Pyro-oxidation
- Neutralization/Drying
- Thermal Desorption and Steam Passivation
- Filtration and Drying

For each technology, it would be necessary to perform a nondestructive assay after the packaging process to ensure compliance with interim safe storage criteria, Waste Isolation Pilot Plant (WIPP)/Waste Acceptance Criteria, and TRUPACT II shipping requirements. The WIPP/Waste Acceptance Criteria are summarized in Table 2–5 of this EIS. One of the criteria limits the amount of packaged fissile gram equivalents to 200 per drum. The assay would allow for maximizing the amount of container loadings, which in turn would minimize the number of drums destined for interim site storage and disposal. The assay would be performed using either neutron multiplicity counters in concert with gamma-ray isotopic spectrometers or by using segmented gamma scanners.

For shipment to WIPP, there are criteria that must be followed in using the TRUPACT II shipping container. Based on these criteria, the residues, where necessary, would be packaged according to the maximum allowable plutonium—83.5 grams (g) (2.9 ounces [oz])—per individual packing container. Since there are two containers per drum, this would ensure that the 200-g limit per drum would not be exceeded. For other residues, where the quantity of plutonium per package is too low to be of concern regarding packaging, the weight of each individual package becomes a concern for handling within a glovebox. An estimated 9.1 kg (25 lb) would be used as a basis for this type of packaging. These values are used throughout this appendix, where appropriate.

C.4 DETAILED PROCESS DESCRIPTIONS FOR NO ACTION PROCESSING TECHNOLOGIES

C.4.1 Calcination and Cementation of Ash Residues

The proposed cement-based immobilization process is an adaptation of a cement-based waste immobilization process that has been used within the DOE complex and the commercial nuclear industry. This process was approved by the U.S. Environmental Protection Agency (EPA) as a best demonstrated available technology for use in waste stabilization. At Rocky Flats, cement-based waste immobilization processes have been operated successfully for several years and have produced thousands of cubic yards of solidified waste. The process has been used for the solidification of low-level waste (saltcrete) in Building 374 and for the solidification of transuranic waste in Building 774 (bottlebox process). The cement-based ash residue solidification process would take place in either Building 707 or Building 371, and it would be an in-container solidification process.

Calcination of powdered or granular materials in muffle furnaces is considered to be a proven technology. Capabilities necessary to satisfy all alternatives are currently being installed at Rocky Flats as part of the ongoing stabilization programs, and should be operational within several months of issuance of the EIS. Cementation of materials necessary to immobilize fines and to form an acceptable solid is considered to be a proven technology, although optimization studies are routinely performed to improve specific characteristics. Rocky Flats would have to install or remodel gloveboxes to provide additional area for the curing step, so approximately one year would be required after the issuance of the Record of Decision before the cementation capability would be fully operational. The specific location of the cementation processing is uncertain, although the process would be consistent with either Building 371 or Building 707.

The cement-based immobilization process is shown in **Figure C–1**. The process steps are drum unloading and bag-in, feed preparation for calcination, calcination, feed preparation for cementation, in-line nondestructive assay, cement mixing station, curing and bag-out, and final drum packaging and storage.

Cement-based immobilization would blend cement and water with the prepared ash residues. The advantage of cement-based immobilization technology is its proven performance. Well-established protocols, when followed, ensure an acceptable final product. Elements included within these protocols include waste characterization, both physical and chemical, treatability formula development, bench scale testing, pilot scale studies, and detailed project planning for full-scale operations.

A cement-based immobilization process has several disadvantages associated with it. The mixing of the cement and water components produces heat during the curing process. Any active metals remaining in the residue stream after calcination may react with water to produce hydrogen gas. Also, during mixing, curing, and after final packaging, the potential for hydrogen generation exists due to both radioalysis and hydrolysis of the water of hydration by the radiological and reactive metal components, respectively.

Two waste streams would be generated in addition to the cemented residue product stream. The first waste stream would be a solid transuranic waste stream consisting of size-reduced steel containers, plastic containers and plastic bags. The second waste stream would be a gaseous effluent stream consisting primarily of water vapor, nitrogen, hydrogen, carbon dioxide and particulates. Any tramp material removed from the waste before size-reduction either would be combined with the solid transuranic waste stream or would be placed into a cemented waste container before curing.

❒ Detailed Process Description

Drums with capacity of 208-liter (L) (55-gallon [gal]) would be transferred from storage into a contamination control enclosure. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the

glovebox. The containers would be removed from the drums and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

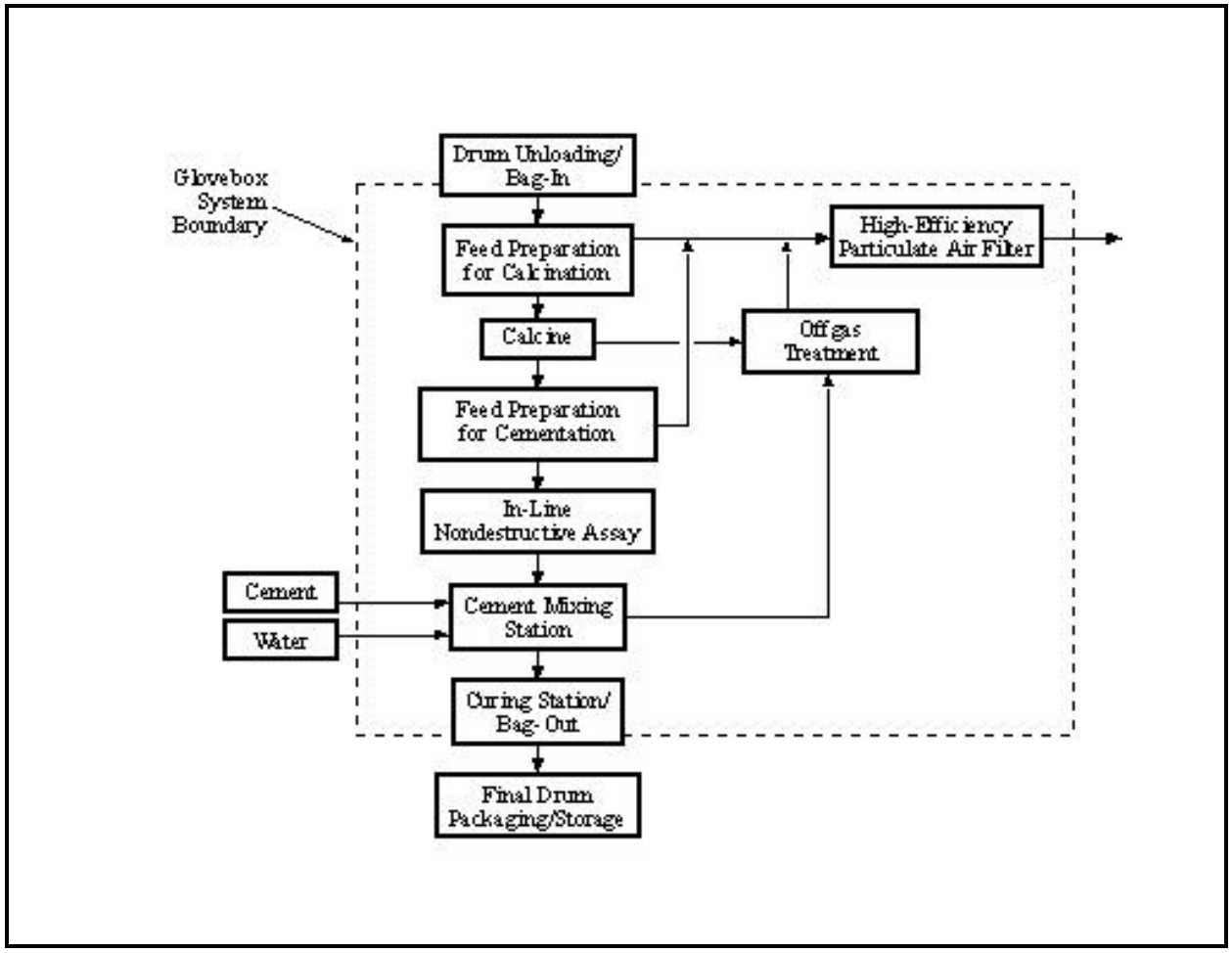


Figure C–1 Cement-Based Immobilization Process for Ash Residues

After bag-in, the Item Description Codes (IDCs) of the residue containers would be verified and the original residue containers would be transferred to a residue sorting and loading station, which would provide local dust control and would contain a 1/8" sieve that would be used to separate all oversized residue and tramp material (e.g., nuts, bolts). The sieved residue fines would be transferred into burn boats. Tramp material would be separated and transferred for transuranic waste size reduction and packaging or placed into cemented waste containers before curing. Oversized residue would be crushed and fed back to the loading station for sieving. Each burn boat would be filled to contain approximately 83.5 g (2.9 oz) of plutonium. After the filling step, the burn boats would be transferred to a furnace for calcination.

Calcination is required to high-fire the incinerator ash residue which would remove the reactive characteristics in the residue stream. Each batch would be calcined at 900 degrees Celsius (°C) [1,650 degrees Fahrenheit (°F)] for 4 hours, which would oxidize carbon and organic to carbon dioxide and eliminate water, thereby increasing the bulk density of the ash residue. After cooling, the residue would be transferred for feed preparation for cementation.

The burn boats containing the calcined residue will be transferred to a residue sorting and loading station. As described previously, the residue would be sieved and the residue fines would be loaded into metal containers. As required, oversized residue will be crushed and loaded into the containers. Each container would be filled to contain approximately 83.5 g (2.9 oz) of plutonium. After the filling step, the containers would be transferred to an in-line nondestructive assay station.

Following nondestructive assay, the container would be moved to the mixing station. Then, measured quantities of water and cement would be blended into the residue containers. The material would be mixed until all of the water has been absorbed by the cement and the mixture thickens. Because of the potential for heat generation, provisions for actively cooling the container during and after mixing may be required for certain residue IDCs. During mixing, there would be a potential for vapor generation produced by an exothermic reaction associated with the hydration of the cement and through hydrogen gas generation produced from radioalysis and hydrolysis. Therefore, provisions would be incorporated as necessary for the collection and extraction of these vapors in both the mixing station and curing station.

The container would be moved from the mixing station into a set of curing gloveboxes and set aside for a 24-hour curing period. After curing has been completed, the cans would be bagged out of the glovebox. Assayed, cemented residue containers would be transferred for final drum packaging. The container would be loaded into pipe components already staged in the drums. The drums would be placed in interim storage until a final disposition decision is made.

C.4.2 Pyro-Oxidation of Pyrochemical Salts

Pyro-oxidation technology converts reactive metals in salt residues to nonreactive oxides. The resulting products would be stored as stabilized plutonium salts at Rocky Flats. This technology would be used on all three types of pyrochemical salt residues, including electrorefining salts, molten salt extraction salts, and direct oxide reduction salts. The pyro-oxidation process would be conducted inside gloveboxes located in Module A of Building 707 or in Building 371.

Pyro-oxidation of salts in stationary furnaces is considered to be a proven technology, although specific process variables are being evaluated in an attempt to make the pyro-oxidation process more compatible with a pyro-distillation follow-on processing step. Pyro-oxidation of reactive salts is part of the Rocky Flats response to Defense Nuclear Facilities Safety Board Recommendation 94-1 to stabilize potentially higher-risk or reactive materials. Rocky Flats has the capability to support the ongoing stabilization programs, and operations are pending. While not a technology risk for the pyro-oxidation process, the salts, once pyro-oxidized, cannot be subsequently salt scrubbed, which is the only current process to allow plutonium separation using the Purex process. The on-going stabilization program trades the technical and programmatic risk of not using a proven Savannah River Site residue disposition approach (Purex) against the reduction of an immediate safety risk. The pyro-oxidation process is, however, a prerequisite step for both salt distillation and aqueous distillation.

The pyro-oxidation process for pyrochemical salts is shown in **Figure C–2**. The salt residues would be sorted and batched in preparation for pyro-oxidation. The residues would be pyro-oxidized to convert reactive metals to oxides. After pyro-oxidation, the oxidized plutonium salts would be packaged for storage. The packaged material would be removed from the glovebox, nondestructively assayed for accountability purposes, and transferred to plutonium storage.

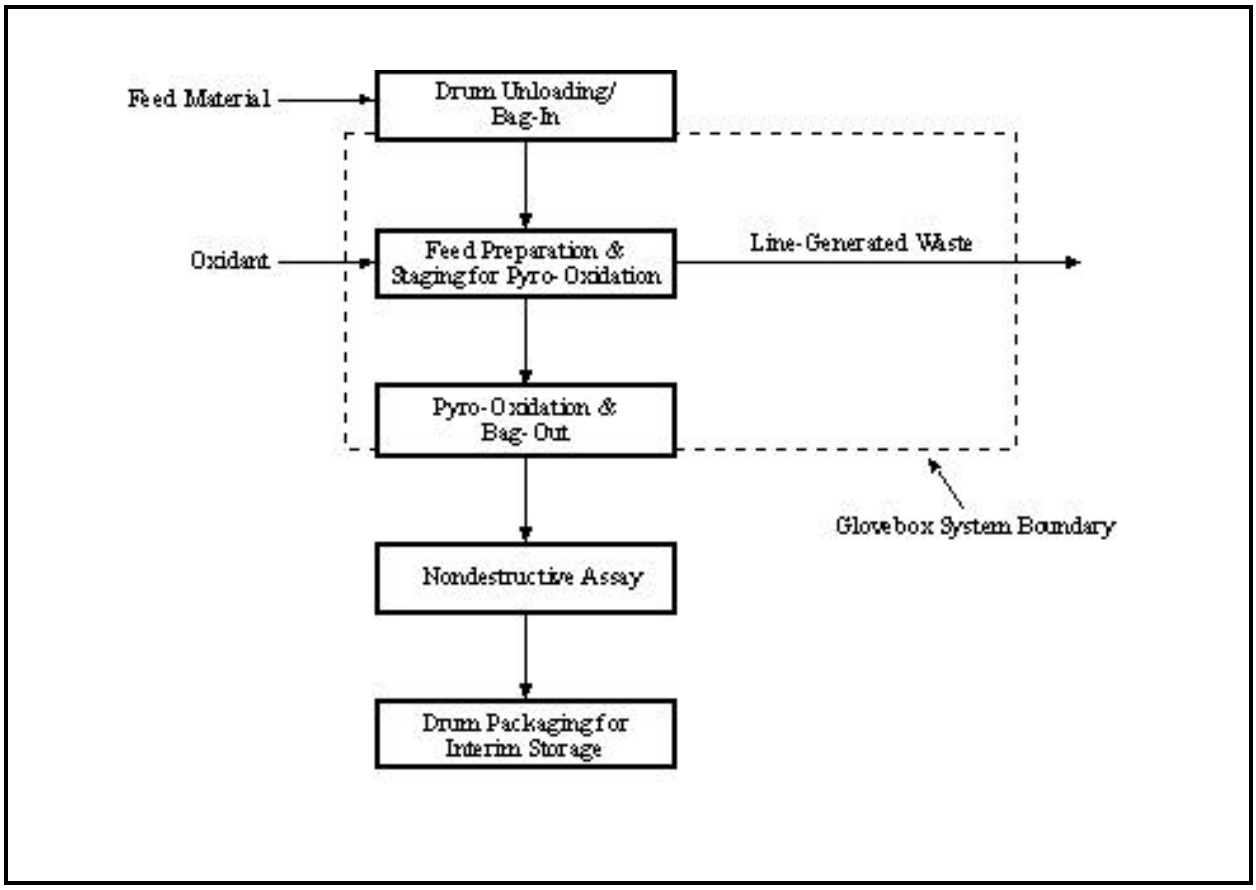


Figure C–2 Pyro-Oxidation Process for Pyrochemical Salts

❒ Detailed Process Description

Drums would be manually transferred into a contamination control enclosure and unpacked. This step is to contain any contamination which could result from an individual package containment damaged by radiolysis, or physical damage to the package during storage. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the salt feed preparation glovebox.

The salt feed would be introduced into the glovebox, one stream at a time, and the IDC verified. The individual packages would be opened and loaded into a crucible in preparation for pyro-oxidation. Sodium carbonate or another oxidant would also be added to the crucible at this time. Combustible packaging materials from the individual packages would be bagged out of the glovebox and managed as transuranic waste. Other materials would be bagged out and managed appropriately.

Once the crucible is loaded with salt feed, it would be placed in a glovebox furnace and heated to approximately 800°C (1,470°F) with sodium carbonate or another oxidant as a reagent for 2 to 3 hours, stirring continuously (8-hour cycle time). The product would be a stabilized plutonium salt matrix. Pyro-oxidation can be applied both to a sodium chloride/potassium chloride matrix and to a calcium chloride matrix. This process converts reactive metals (such as calcium and sodium) to oxides. When the furnace has cooled to below 100°C (212°F), the crucible would be removed from the furnace. During the heating, stirring, and cooling phases, argon would flow through the furnace. During the last part of the heating phase, argon would be replaced by a mixture of air and argon.

Once the crucible is removed from the furnace, it would be allowed to cool. Because metal crucibles are used, the pyro-oxidized salt would remain in the crucibles to be sealed and bagged out directly in nominal 2.5–kg (5.5 lb) bulk (net) batches. The material would then be bagged from the glovebox and placed into containers for plutonium storage.

Nondestructive assay would be performed to ensure requirement limits are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data are obtained. Assayed product packages containing the plutonium-bearing salt matrix would be transported to appropriate plutonium storage areas.

C.4.3 Neutralization and Drying of Aqueous-Contaminated Combustibles

Aqueous-contaminated combustible residues include acidic liquids and generally do not have free liquid present. They were generated from an aqueous process and some degree of moisture will be present. The neutralization and drying process for aqueous-contaminated combustible residues removes the nitric acid from the organic matrix, eliminating a possibly unstable condition. The residue consists of materials, such as cloth, paper, rags, coveralls, rubber, wood, and other miscellaneous materials, some of which is above the safeguards termination limit for combustibles. The neutralization and drying process is not intended to remove the plutonium from the residue. As a result, this process would preclude ultimate shipment to WIPP unless the residue is subjected to further processing. This process would be conducted in Room 3701 of Building 371.

The neutralize-dry process, consisting of washing materials in alkaline solutions, allowing them to drain or partially dry, and mixing the resulting solids with water-absorbing materials, is considered to be a proven technology. The capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. Activities are underway to optimize the process and reduce the quantity of water-absorbing materials required for meeting disposal requirements.

The neutralization and drying process for aqueous-contaminated combustible residues is shown in **Figure C–3**. The process steps are drum unloading and bag-in, feed preparation, the neutralization and decant/filtration, oven drying, and packaging and bag-out. Nondestructive assay would be performed and the drums would be packaged for interim site storage.

❒ Detailed Process Description

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the package would be transferred into the glovebox.

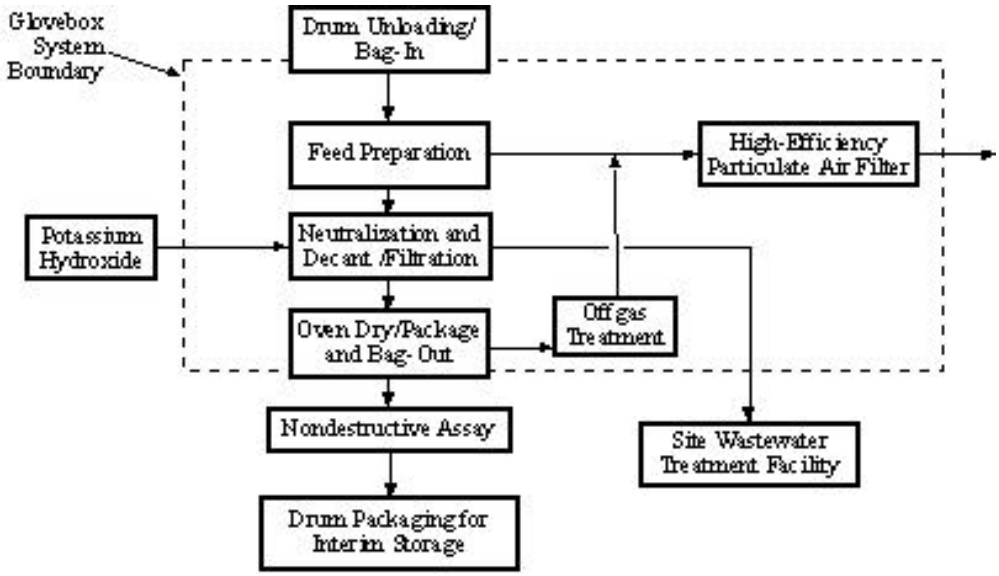


Figure C–3 Neutralization and Drying Process for Aqueous-Contaminated Combustible Residues

Any unnecessary packaging materials, would be removed to limit the amount of packaging introduced into the glovebox. If the integrity of the primary packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

Following bag-in, the IDCs would be verified and the plastic bags would be unpacked and the residue sorted. Each bag would be opened to remove any tramp metal or other unwanted materials. This material would be bagged out of the glovebox and managed appropriately. Following the sorting, the residue feed material would be shredded and batched to 5-kg (11-lb) batches for neutralization.

Neutralization is intended to remove the nitrate contamination from the combustible waste and to neutralize any residual nitric acid contained within the residue. The 5-kg (11-lb) batches of combustible would be washed with 50 L (13.2-gal) of water containing 10 percent excess potassium hydroxide. After 2 hours, the acid would be neutralized, forming potassium nitrate and water. None of the plutonium would be removed from the residue during the neutralization process. The combustible solids would be separated from the nitrate solution and processed through decanting and filtration. The combustible solids would contain approximately 20 percent solution by weight with a proportionate quantity of nitrates. These solids would be transferred to a drying pan. The neutralization solution would be sent, at intervals, to Building 374 for evaporation using the site wastewater treatment process.

The combustible residue that was neutralized and transferred to a drying pan would then be placed into a drying oven. The residue would be dried under a vacuum at 80°C (176°F) for 2 hours. Offgas from drying will be treated before high-efficiency particulate air filtration. After cooling, the combustible residue would be weighed, and the quantity of plutonium estimated as the waste would be transferred to 8.2-L (2.2-gal) containers. Each container would contain approximately 44.6 g (1.6 oz) of plutonium with the container loading based on an approximate bulk density of the solids of 0.3 kg/L (2.5 lb/gal). These containers would be bagged out of the glovebox and packaged into convenience cans. None of the plutonium would be removed in the neutralization; therefore, the plutonium remaining in the combustibles would be above the safeguards termination limit and would preclude shipment and disposal of this population at WIPP.

Nondestructive assay would be performed, and then the assayed and repackaged residue containers would be transported for drum packaging. These 208-L (55-gal) drums cannot be shipped to WIPP because the percentage of plutonium in the waste exceeds the safeguards termination limit. The drums would remain in the interim site storage until subjected to an appropriate stabilization process that would reduce the plutonium content below the safeguards termination limit.

C.4.4 Thermal Desorption and Steam Passivation of Organic-Contaminated Combustibles

Thermal desorption and steam passivation removes residual organic contaminants from organic-contaminated combustible residues and converts plutonium fines in the residue to plutonium oxide. Organic-contaminated combustible residues consist of materials, including wet and dry combustibles and leaded rubber gloves, some of which are above the safeguards termination limit for combustibles. The thermal desorption and steam passivation process and the repackaging of this material would satisfy the requirements for safe interim site storage. This process would be conducted in Room 3701 of Building 371.

Thermal desorption/steam passivation to remove volatile organics and oxidize plutonium fines is considered to be a proven technology; however, the processing times are currently under investigation as are final process parameters. The capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS.

The thermal desorption and steam passivation process for organic-contaminated combustible residues is shown in **Figure C–4**. The process steps include drum unloading/bag-in and feed preparation, followed by thermal desorption and steam passivation. Absorbent is added and the material repackaged and bag-out. After nondestructive assay is performed, the final drum packaging and storage would take place.

❒ Detailed Process Description

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the package would be transferred into the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the glovebox. If the integrity of the primary packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

Following bag-in, the IDCs would be verified and the plastic bags would be unpacked and the residue sorted. Each bag would be opened to remove any tramp metal or other unwanted materials. This material would be bagged out of the glovebox and managed appropriately. Following the sorting, the residue feed material would be shredded and batched to 1 kg (2.2 lb) for thermal desorption/steam passivation.

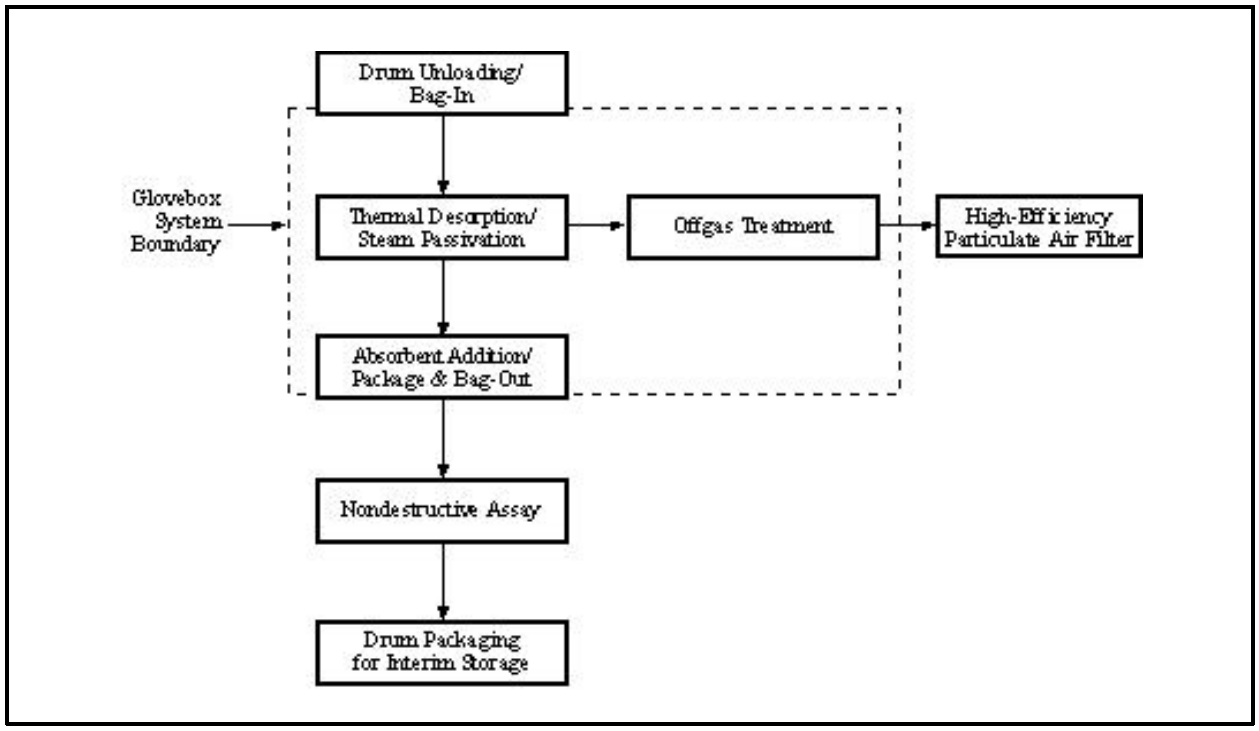


Figure C–4 Thermal Desorption/Steam Passivation Process for Organic-Contaminated Combustible Residues

Thermal desorption is intended to remove the organic solvent contaminants from the combustible residue. The 1-kg (2.2-lb) batches of combustible residue would be heated to 80°C (176°F) for 2 hours under reduced pressure to volatilize the organic solvent contaminants. The offgases would be collected on granulated activated charcoal. Then, low temperature steam would be injected for 1 hour to oxidize any plutonium fines present in the residue.

The processed combustible residue would be allowed to cool to room temperature and approximately 1 kg (2.2 lb) of dry absorbent would be added to dry the wet matrix. The residue would then be batched to approximately 4 kg (8.8 lb) and placed into an 8.2-L (2.2-gal) container. The 4-kg (8.8-lb) batch is based on the volume of shredded combustible waste and absorbent that may reasonably fit into an 8.2-L (2.2-gal) container. The can would be sealed, taped, and bag-out of the glovebox and placed into a 30.5-centimeter (cm) (12-inch [in]) convenience can. Each can would contain approximately 37.8 g (1.3 oz) of plutonium.

Nondestructive assay would be performed and the assayed and repackaged residue containers would be transported for final drum packaging. The containers would be transferred for final drum packaging and then placed in interim storage until a final disposition decision is made.

C.4.5 Repackaging of Dry Combustibles

Repackaging of dry combustibles would be performed to achieve the criteria for safe interim site storage. Dry combustible residue consists of such materials as paper, rags, cloth, plastic, wood, surgical gloves, tape, paper coveralls, booties, personal protective equipment waste, full-face masks, v-belts, polyvinyl chloride, polyethylene, polypropylene, supplied-air suits, and gaskets, some of which are above the safeguards termination limit for combustibles. After repackaging, the combustible residues above the safeguards

termination limit would remain above the limit. This would preclude ultimate shipment of this material to WIPP unless it is subjected to further processing. Preparation of direct repackage residues would be conducted within glovebox lines in Modules D, E and F of Building 707.

Repackaging to package and assay appropriate residues is considered to be a proven technology. The capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS.

The direct repackage process is shown in **Figure C–5**. The process steps include drum unloading and bag-in, feed preparation and repackaging, and bag-out. Nondestructive assay would be performed and the drums would be packaged for interim site storage.

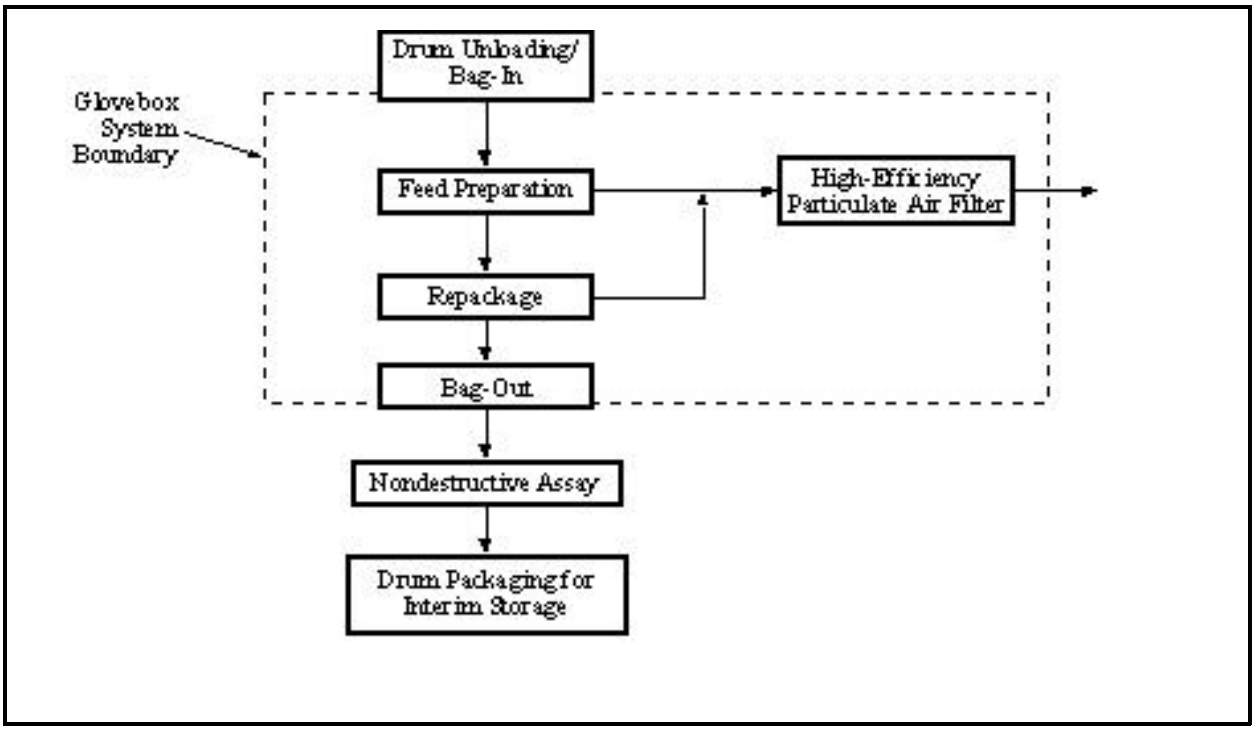


Figure C–5 Direct Repackaging Process for Dry Combustibles

❒ **Detailed Process Description**

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure in Module D of Building 707. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the package would be transferred into the glovebox in Module E of Building 707. Other packaging materials would be removed from the drum and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

Following bag-in, the plastic bags would be unpacked and the residue sorted. The residue would then be repackaged into metal containers. If the material requires size-reduction and/or compaction to minimize the volume of the repackaged residue, the sorted residue would be transferred to a size-reduction station. The residue would be shredded and repackaged into metal containers. If required, the repackaged material would be compacted within the metal containers to gain additional volume reduction, which would reduce

the number of drums requiring shipment to WIPP. Each repackaged container would be filled to approximately 83.5 g (2.9 oz) of plutonium. After the container filling step, the sealed container would be bagged out and transferred to nondestructive assay.

Nondestructive assay would be performed and the assayed and repackaged residue containers would be transported into Module F of Building 707 for drum packaging. Two containers would be loaded into a pipe component which would be staged inside of a 208-L (55-gal) drum. These drums cannot be shipped to WIPP because the percentage of plutonium in the waste exceeds the safeguards termination limit. The drums would remain in interim site storage until subjected to an appropriate stabilization process that would reduce the plutonium content below the safeguards termination limit.

C.4.6 Acid Dissolution and Plutonium Oxide Recovery of Plutonium Fluorides

Acid dissolution of plutonium fluorides would involve dissolution of the fluorides, followed by precipitation and filtration of plutonium oxalate, and calcination to plutonium oxide for storage. The filtrate from the oxalate precipitation would be treated with magnesium hydroxide to precipitate the plutonium remaining in the solution. That precipitate would then be filtered, calcined, repackaged, and placed in interim site storage until a final disposition decision is made. The dissolution process would be conducted inside gloveboxes located in Room 3701 of Building 371.

The acid dissolution/plutonium oxide recovery process is considered to be a proven technology. The process to be used for the limited quantities of materials identified in these categories would be consistent with equipment and activities that can be performed in the neutralize-dry process area. Thus, the capability for Rocky Flats is currently being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. However, the use of this equipment for Acid Dissolution would generally be preceded by the neutralize-dry processing of the combustible residues required by the Defense Nuclear Facilities Safety Board Recommendation 94-1 stabilization program, and may not be able to start until 4 years after issuance of the Record of Decision.

The plutonium fluoride acid dissolution process is shown in **Figure C–6**. The feed materials would be unpacked and batched for acid dissolution. The dissolved fluorides would be sent through precipitation to form plutonium oxalate precipitate in slurry form, which would then be filtered to separate the effluent solution from the precipitate. The oxalate would be calcined, nondestructively assayed, calcined again for long-term storage, again nondestructively assayed, and then packaged for storage. Magnesium hydroxide would be mixed into the oxalate precipitation effluent to precipitate the remaining plutonium, and the effluent filtered to form magnesium hydroxide and effluent. The magnesium hydroxide would be calcined and packaged. The packaged magnesium hydroxide product would be removed from the glovebox and nondestructively assayed for accountability purposes, packaged in the final transport/storage container, and placed in interim storage. The last filtration effluent would be sent for evaporation at the Rocky Flats wastewater treatment facility.

Most of the fluoride residues are located in the Building 371 storage vault, and would be transferred from the vault into the glovebox system by a remote handling system through an input/output station. Other fluoride packages would be manually transferred and bagged into the feed preparation glovebox.

❒ Detailed Process Description

The residue feed would be introduced into the glovebox, and the IDC will be verified. The materials would then be removed from the containers and batched to a maximum of 200 g (7 oz) of plutonium in preparation for nitric acid dissolution. Combustible packaging materials from the individual containers would be

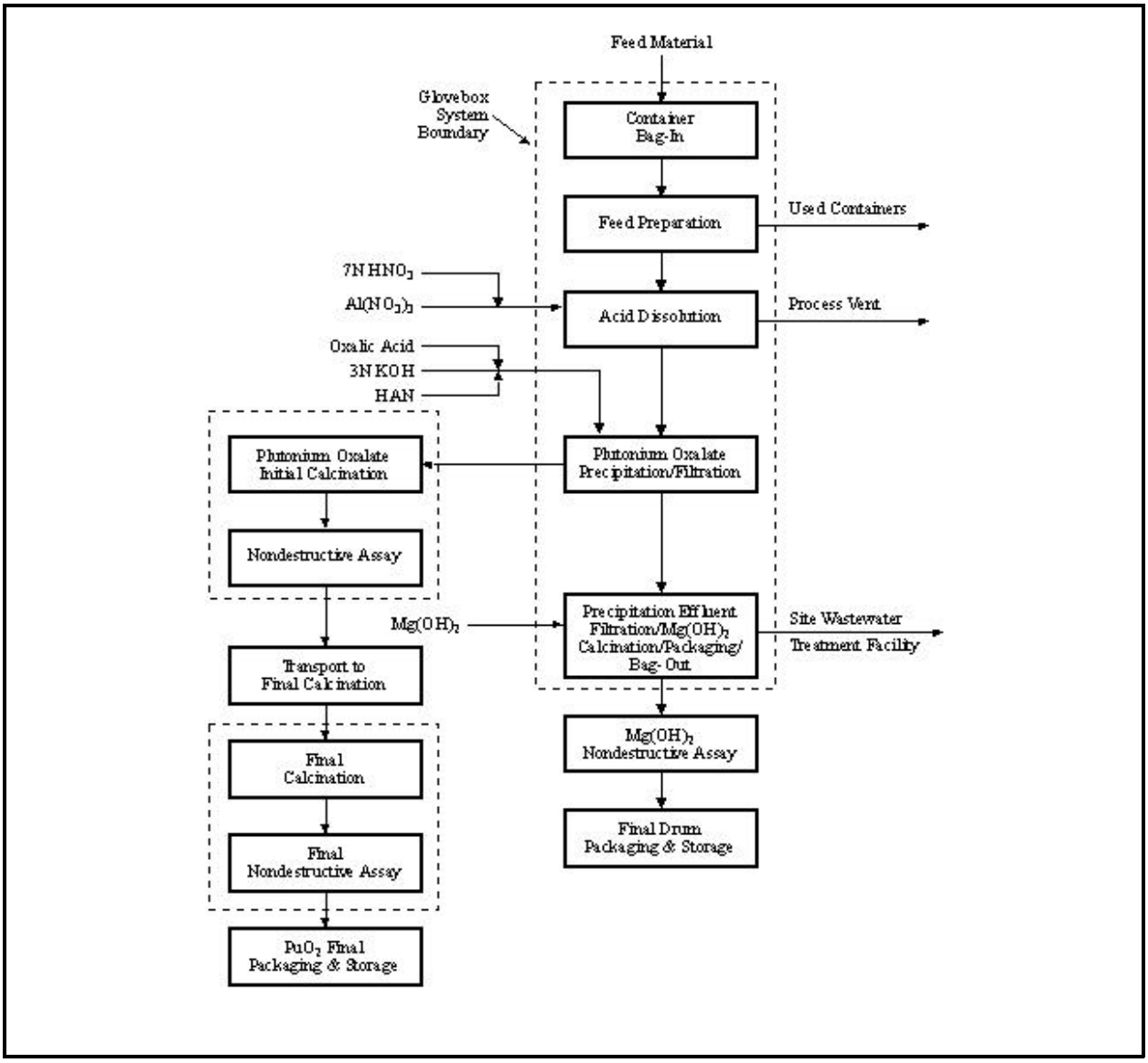


Figure C–6 Acid Dissolution Process for Plutonium Fluorides

bagged out of the glovebox and sent to a combustible handling process. Other unwanted materials would be bagged out of the glovebox and managed appropriately.

The contents of the residue cans would be transferred to one of two heated stirrers. The operator would add 7N nitric acid (HNO_3) and 60 percent aluminum nitrate ($Al(NO_3)_3$) solution to each dissolver before stirring. $Al(NO_3)_3$ would be added to complex residue ions during dissolution. The slurry would be heated to approximately 80°C (176°F) and stirred until dissolution is achieved. Vented fumes would be cooled in a condenser, and then piped to the process vent system. The batch would be filtered to remove any undissolved solids and then split into two equal amounts and transferred to the adjacent heated stirrers for precipitation.

For plutonium oxalate precipitation, 3N potassium hydroxide (KOH) would be added to each can to adjust the normality to 0.75N nitric acid. Hydroxylamine nitrate (HAN) would then be added as a 1.9M solution to adjust the plutonium valence to +3. After these adjustments have been made, solid oxalic acid would be

added to form plutonium oxalate precipitate. The solution would be heated to approximately 80°C (176°F) and stirred to form a slurry.

The slurry from the two stirrer assemblies would be poured onto an R-4 filter. Filtration of plutonium oxalate would be achieved by pulling a vacuum through the filter and drawing effluent liquids into a filtrate tank. The plutonium oxalate precipitate would be scooped into a filter boat in preparation for calcining.

The plutonium oxalate would require calcining at 450°C (840°F) to convert the oxalate into the oxide form. In this process, the filter boat would be placed on a pneumatic lift, placed into the calcination furnace, and the precipitate would be heated to 450°C (840°F). Glovebox air would be drawn down through the precipitate at a rate of approximately 0.10 cubic meter (m^3) (3.5 cubic feet [ft^3]) per minute during the heating cycle. After a cooling cycle, the calcined oxide would be transferred from the filter boat back into a can, batched to 1,000 g (2.2 lb), sealed, and sent to calorimetry.

The plutonium oxide can would be assayed for plutonium content based on its rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. This activity is required to maintain accountability within the acid dissolution material balance area. After assay, the containers would be ready for final calcination. The cans containing the plutonium oxide would be placed into appropriate outer containers and transferred to the Building 371 loading dock. The containers would then be transported to the Building 707 loading dock by intra-site truck transportation, and moved to appropriate vault storage pending final calcination.

The plutonium oxide cans would be transferred from the Building 707 storage vault to Module J and bagged into the plutonium stabilization and packaging system. The plutonium oxide would be removed from the cans, placed into furnaces, and calcined at 1,000°C (1,830°F) for 8 hours. The material, now suitable for long-term storage or transportation, would be weighed, characterized, and placed into a 3013 inner container. This container would then be removed from the glovebox by the bagless transfer process and sent to calorimetry. The plutonium oxide package would be assayed for plutonium content based on its rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be placed into vault storage, pending a final disposition decision.

Magnesium hydroxide, $Mg(OH)_2$, 30 percent by weight, would be added to the effluent liquid in the filtrate tank from the precipitation filtration step, and the tank would be mixed by sparging. The liquid and precipitate would then be drained onto an R-4 filter. Filtration would be achieved by pulling a vacuum through the R-4 filter and drawing effluent liquids into the transfer tank. The magnesium hydroxide precipitate would then be scooped into a filter boat in preparation for calcining. The magnesium hydroxide would be calcined at 450°C (840°F). In this process, the filter boat would be placed on a pneumatic lift, placed into the calcination furnace, and the precipitate would be heated to 450°C (840°F). Glovebox air would be drawn down through the precipitate at a rate of approximately 0.10 m^3 (3.5 ft^3) per minute during the heating cycle. After a cooling cycle, the calcined hydroxide would be transferred from the filter boat back into a can, batched to 9.1 kg (20 lb), sealed, and bagged out into convenience cans.

Nondestructive assay of the magnesium hydroxide would be performed to ensure requirements limit are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data are obtained. Assayed product packages would be selected for final packaging to minimize the number of shipping containers and placed in interim storage pending a final disposition decision. Selected packages would be loaded into an inner container and sealed before placing the container into the final outer shipping container.

C.4.7 Neutralization and Drying of Filter Media

The neutralization and drying process for filter media residues would treat the nitric acid contaminant on the residue to eliminate the potential flammable hazard. The neutralization and drying process is not intended to remove the plutonium from the residue. As a result, this would preclude ultimate shipment to WIPP unless the residue is subjected to further stabilization processing. This process would be conducted in Room 3710 of Building 371.

The neutralize-dry process, consisting of washing materials in alkaline solutions, allowing them to drain or partially dry, and mixing the resulting solids with water-absorbing materials, is considered to be a proven technology. The capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. Activities are underway to optimize the process and reduce the quantity of water-absorbing materials required for meeting disposal requirements.

The neutralization and drying process for filter media residues is shown in **Figure C–7**. The process steps are drum unloading and bag-in, feed preparation, the neutralization and decant/filtration, oven drying, packaging, and bag-out. Nondestructive assay would be performed, and the drums would be packaged for interim site storage.

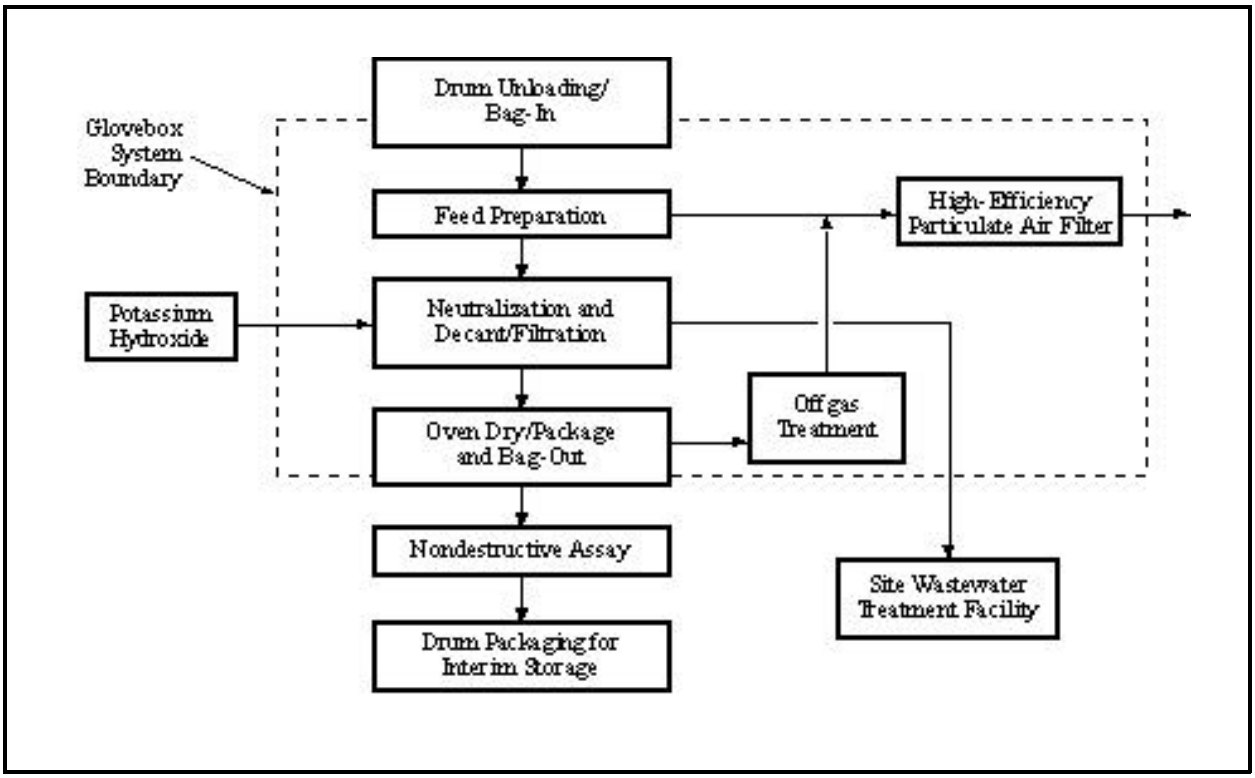


Figure C–7 Neutralization and Drying Process for Filter Media

❒ Detailed Process Description

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be

checked. If the packaging has not been compromised, the package would be transferred into the glovebox. Any unnecessary packaging materials, would be removed to limit the amount of packaging introduced into the glovebox. If the integrity of the primary packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

Following bag-in, the IDCs would be verified and the plastic bags would be unpacked and the residue sorted. Each bag would be opened to remove any tramp metal or other unwanted materials. High-efficiency particulate air filter frames and stiffeners would be separated from the filter media. These materials would be bagged out of the glovebox and managed appropriately. Following the sorting, the residue feed material would be shredded and batched to 5-kg (11-lb) batches for neutralization.

Neutralization is intended to remove the nitrate contamination from the combustible waste and to neutralize any residual nitric acid contained within the residue. The 5-kg (11-lb) batches of combustible residues would be washed with 50 L (13.2 -gal) of the water containing 10 percent excess potassium hydroxide. After 2 hours, the acid would be neutralized forming potassium nitrate and water. None of the plutonium would be removed from the residue during the neutralization process. The combustible solids would be separated from the nitrate and plutonium containing solution by decanting and filtration. The combustible solids would contain approximately 20 percent solution by weight with a proportionate quantity of nitrates and transferred to a drying pan. At intervals, as required during the process, the neutralization solution would be sent to Building 374 for evaporation using the site wastewater treatment process.

The filter media residue that had been neutralized and transferred to the drying pan would then be placed into a drying oven. The residue would be dried under a vacuum at 80°C (176°F) for 2 hours. Offgas from drying would be treated before high-efficiency particulate air filtration. After cooling, the residues would be weighed, and the quantity of plutonium estimated as the waste would be transferred to 8.2-L (2.2-gal) containers. Each container would hold approximately 83.5 g (2.9 oz) of plutonium. The containers would be bagged out of the glovebox and packaged into convenience cans for transfer to nondestructive assay.

Nondestructive assay would be performed and the assayed and packaged residue containers would be transported for drum packaging. These drums cannot be shipped to WIPP because the percentage of plutonium in the waste exceeds the safeguards termination limit. The drums would reside in interim site storage until subjected to an appropriate stabilization process that would reduce the plutonium content below the safeguards termination limit.

C.4.8 Filtration and Drying of Sludge Residues

The filtration and drying process for sludge residues filters off any excess liquid and drys the remaining material by mixing it with an absorbent. After drying and repackaging, the sludge residues would be placed in interim storage pending a final disposition decision. This process would be conducted in Room 3701 of Building 371.

The filter-dry process, consisting of allowing wet materials to drain and partially dry, and mixing the resulting solids with water-absorbing materials, is considered to be a proven technology. The capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. Activities are underway to optimize the process and reduce the quantity of water-absorbing materials required for meeting disposal requirements.

The filtration and drying process for sludge residues is shown in **Figure C–8**. The process steps are drum unloading and bag-in, feed preparation and decant/filtration, absorbent addition, and bag-out. Nondestructive assay would be performed, followed by drum packaging for interim site storage.

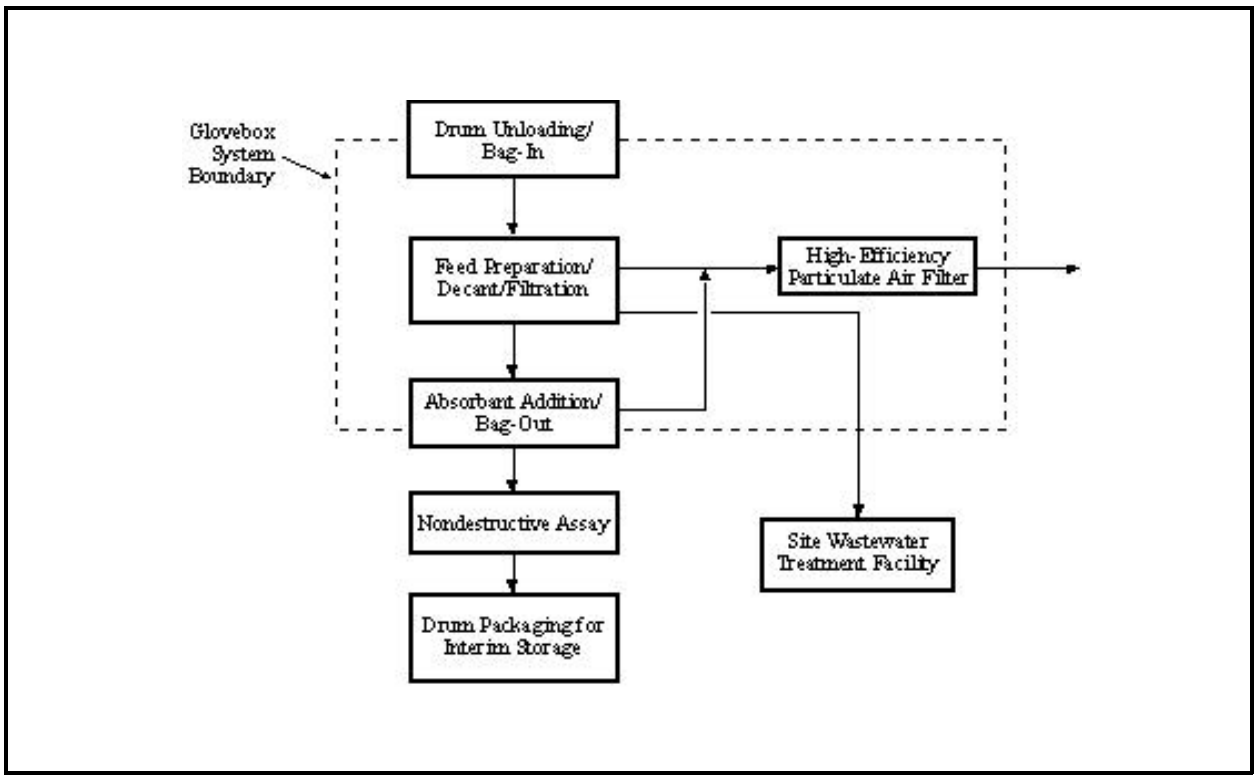


Figure C–8 Filtration and Drying Process for Sludge Residues

❒ **Detailed Process Description**

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging checked. If the packaging has not been compromised, the package would be transferred into the glovebox. Any unnecessary packaging materials, would be removed to limit the amount of packaging introduced into the glovebox. If the integrity of the primary packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

Following bag-in, IDCs would be verified, containers would be unpacked, and the residues would be sorted. Any unwanted materials found in the sludge, such as plastics or metals, would be bagged out of the glovebox and managed appropriately. As required, free liquids would be decanted and vacuum filtered to collect any suspended solids. At intervals, as required during the process, the decanted and filtered liquids would be sent to the site wastewater treatment process in Building 374 for evaporation. After decanting, the sludge would be removed from the container and the resulting packaging materials would be bagged out of the glovebox and managed appropriately. The sorted residue material would be weighed into 8.2-L (2.2 -gal) containers. The amount of residue added to the container would be based on the total weight of the container, after absorbent addition, being 9.09 kg (20.0 lb) or less to meet physical handling constraints. Dry absorbent would be blended with the wet sludge residue for absorbent addition at a ratio of 4 parts absorbent to 1 part sludge, by weight. After blending, the containers would be sealed with a lid and bagged

out of the glovebox. The containers would be placed in convenience cans, sealed and taped, and sent to nondestructive assay.

The assayed and packaged residue containers would be transported for drum packaging, which would include first placing the containers into pipe components. The drums would be transferred to interim storage until a final disposition decision is made.

C.4.9 Neutralization and Drying of Glass Residues

The neutralization and drying process for glass residues would treat the nitric acid contaminant on the residue. This process may remove up to 99 percent of the plutonium from the residue based on results from washing Raschig rings. This process would be conducted in Room 3701 of Building 371.

The neutralize-dry process, consisting of washing materials in alkaline solutions, allowing them to drain or partially dry, and mixing the resulting solids with water-absorbing materials, is considered to be a proven technology. The capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. Activities are underway to optimize the process and reduce the quantity of water-absorbing materials required for meeting disposal requirements.

The neutralization and drying process for glass residues is shown in **Figure C–9**. The process steps are drum unloading and bag-in, feed preparation, neutralization and decant/filtration, and oven drying, packaging, and bag-out. Nondestructive assay would be performed, followed by drum packaging for interim site storage.

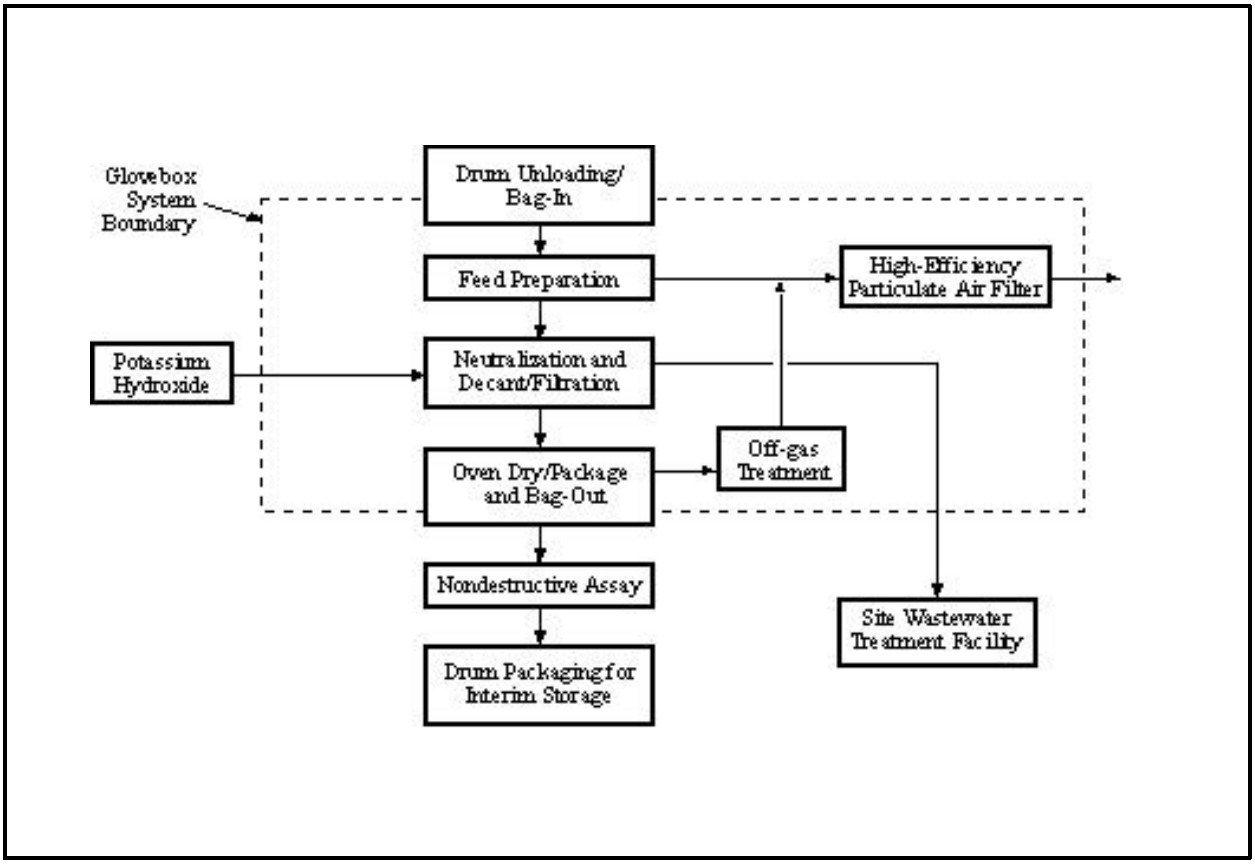


Figure C–9 Neutralization and Drying Process for Glass Residues

❒ **Detailed Process Description**

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging checked. If the packaging has not been compromised, the package would be transferred into the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the glovebox. If the integrity of the primary packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

Following bag-in, the IDCs would be verified, and the containers would be unpacked and the residue sorted. Any unwanted materials would be bagged out of the glovebox and managed appropriately. As required, the sorted residue material would be size-reduced by crushing and batched to 5-kg (11-lb) batches for neutralization.

Neutralization is intended to remove the nitrate contamination from the glass waste and to neutralize any residual nitric acid on the residue. The 5-kg (11-lb) batches of residue would be washed with 50 L (13 -gal) of water containing 10 percent excess potassium hydroxide. After 2 hours, the acid would be neutralized forming potassium nitrate and water. The neutralization process should remove approximately 99 percent of the plutonium from the residue. The residue solids would be separated from the nitrate and plutonium-containing solution by decanting and filtration. The residue, after neutralization, would contain approximately 0.5 percent neutralization solution by weight with a proportionate quantity of nitrates and transferred to a drying pan. At intervals, as required during the process, the neutralization solution with the removed plutonium would be sent to the site wastewater treatment process in Building 374 for evaporation.

The glass residue, neutralized and transferred to the drying pan, would then be placed into a drying oven. The residue would be dried under a vacuum at 80°C (176°F) for 2 hours. Off-gas from drying would be treated before high-efficiency particulate air filtration. After cooling, the residue would be weighed and the quantity of plutonium estimated as the waste is transferred to plastic bags. These bags would be bagged out of the glovebox and packaged in 8.2-L (2.2-gal) containers to approximately 42.9 g (1.5 lb) of plutonium per container based on a maximum container weight of 9.09 kg (20.0 lb) because of physical handling constraints. After being removed from the glovebox, the containers would be packaged into convenience cans.

Nondestructive assay would be performed, and the assayed and packaged residue containers would be transported for drum packaging, which includes first placing the containers into pipe components. The drums would be transferred to interim storage until a final disposition decision is made.

C.4.10 Repackaging of Graphite Residues, Inorganic Residues, and Scrub Alloy

Repackaging of graphite and inorganic residues and scrub alloy would be performed to achieve the criteria for safe interim site storage. For the graphite and inorganic residues, after repackaging, the residues would remain above the safeguards termination limits, which would preclude ultimate shipment to WIPP unless the material is subjected to further stabilization. Preparation of direct repackage residues for all three materials would be conducted within glovebox lines in Modules D, E and F of Building 707.

Repackaging to package and assay appropriate residues is considered to be a proven technology. The capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS.

The direct repackage process is shown in **Figure C–10**. The process steps are drum unloading and bag-in, feed preparation (for graphite and inorganic), container examination and verification (for scrub alloy), repackaging, and bag-out. Nondestructive assay would be performed, followed by drum packaging for interim site storage.

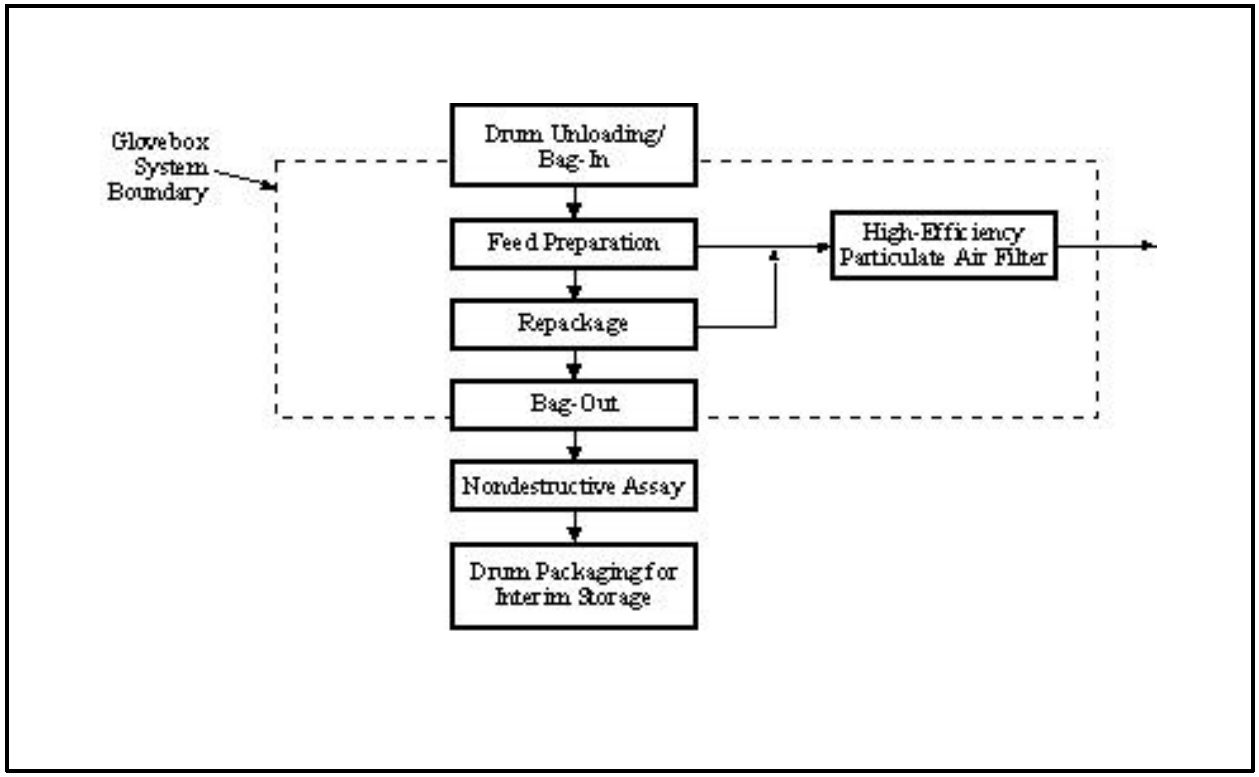


Figure C–10 Direct Repackaging Process for Graphite and Inorganic Residues

❒ Detailed Process Description

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure in Module D of Building 707. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox in Module E of Building 707. The containers, including outer packaging materials, would be removed from the drum and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

For the graphite and inorganic residues, following bag-in, the plastic bags would be unpacked and the residue sorted. The residue would then be repackaged into metal containers. If the material requires size-reduction and/or compaction to minimize the volume of the repackaged residue, the sorted residue would be transferred to a size-reduction station, after which the residue would be repackaged into metal containers. If required, the repackaged material would be compacted within the metal containers to gain additional

volume reduction. Each repackaged container would be filled to approximately 83.5 g (2.9 oz) of plutonium. After the container filling step, the sealed container would be bagged out and transferred to nondestructive assay. The assayed and repackaged residue containers would then be transported into Module F of Building 707 for drum packaging. The containers would be loaded into 208-L (55-gal) drums. These drums cannot be shipped to WIPP because the percentage of plutonium in the waste exceeds the safeguards termination limit. The drums would reside in interim site storage until subjected to an appropriate stabilization process that would reduce the plutonium content below the safeguards termination limit for graphite and inorganic residues.

For the scrub alloy, following bag-in, the containers housing the scrub alloy buttons would be unpacked. The scrub alloy would then be repackaged into metal containers meeting the safe storage standard. After the scrub alloy button is repackaged, the sealed container would be bagged out and transferred to nondestructive assay. The assayed and repackaged residue containers would then be transported to Building 371 for safe interim site storage. These containers cannot be placed into pipe components, drummed, and shipped to WIPP because the percentage of plutonium exceeds storage limits. The containers would reside in interim site storage until subjected to an appropriate stabilization process.

C.5 Detailed Process Descriptions for Processing Technologies without Plutonium Separation

C.5.1 Immobilization (Vitrification)

For ash, high-efficiency particulate air filter media, sludge, glass, graphite, and inorganic residues, the proposed vitrification immobilization process would use a furnace vitrification technology similar in concept to calcination. This process has been proposed for interim processing to allow safe interim storage at Rocky Flats until shipment to WIPP is approved. The process would be conducted in gloveboxes located in Module D, E, and F of Building 707 using muffle furnaces to heat the residue material to approximately 700 to 1,300°C (1,300 to 2,400°F) for 4 hours. The end product would consist of a solidified monolith contained inside a 20-cm (8-in) diameter by 25.4-cm (10-in) high metal can.

Calcination of powdered or granular materials in muffle furnaces is considered to be a proven technology. Capabilities necessary to satisfy all alternatives are being installed at Rocky Flats as part of the ongoing stabilization programs, and should be operational within several months after issuance of the EIS. The vitrification process is also considered to be a proven technology for most residue types to which it may be applied. A technical development program is underway for the vitrification of ash residues. The muffle furnace capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. Activities are underway to optimize the process and reduce the steps necessary to achieve an acceptable waste form.

The vitrification process for residues is shown in **Figure C–11**. The process steps are drum unloading, feed preparation, vitrification, and bag-out. Nondestructive assay would be performed, followed by final drum packaging and storage.

The proposed vitrification for scrub alloy requires a two-step heating process. First, the scrub alloy would be converted to an oxide by calcining at 600°C (1,100°F) and 1,000°C (1,800°F), respectively. Then, calcined scrub alloy would be blended with frit and vitrified using the furnace vitrification process. This entire process would be conducted in gloveboxes located in Modules D, E, and F of Building 707, similar to the residues. The calcining and vitrification steps would use identical muffle furnaces.

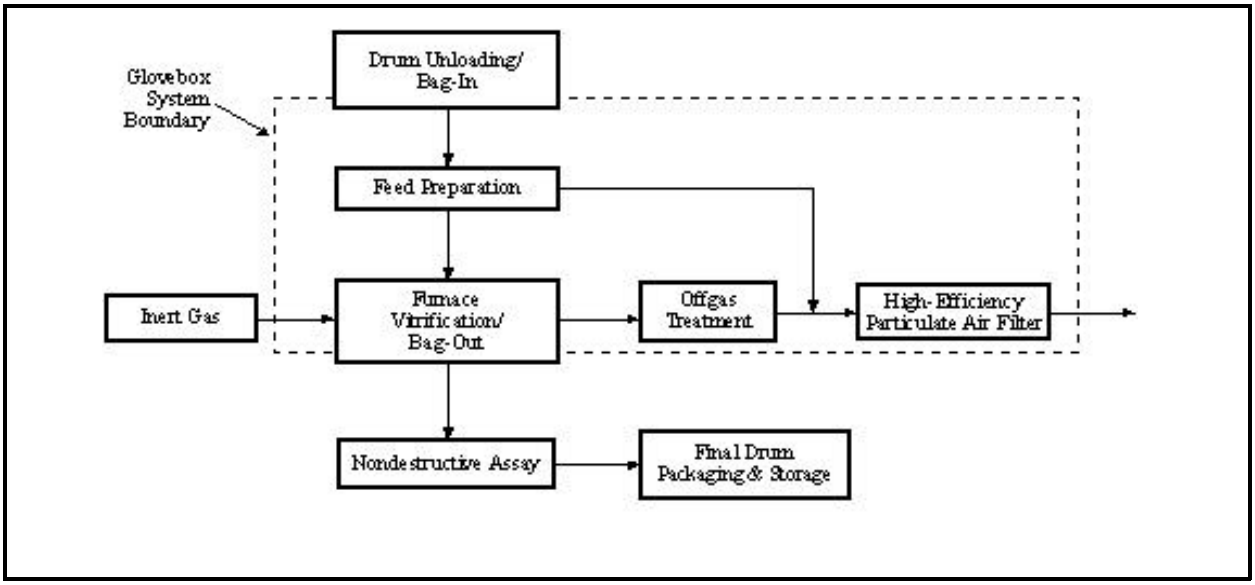


Figure C–11 Furnace Vitrification Process for Residues

Since the calcination of powdered or granular materials in muffle furnaces is considered to be a proven technology and plutonium metals and other alloys have been routinely burned in the past, calcination of scrub alloy is considered to be a low-risk technology although not specifically proven in this context. Capabilities necessary to satisfy all alternatives are being installed at Rocky Flats as part of the ongoing stabilization programs, and should be operational within several months of issuance of the EIS. The vitrification process is considered a proven technology for most residue types for which it may be applied. The muffle furnace capability for Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. The disposition of scrub alloy through a calcination and vitrification process was not envisioned as a disposal approach at the time of the WIPP EIS and therefore was not included in the WIPP Baseline Inventory Report. In the event that this technology would be implemented, the resulting transuranic waste, although of satisfactory composition and form, might be subject to delays in disposal due to the necessity of revising regulatory documentation. Since this material has historically been considered "War Reserve" material, its final disposition to WIPP has not been programmatically evaluated. As such, DOE does not consider the calcination and vitrification of scrub alloy at Rocky Flats to be a preferred processing technology.

The process to vitrify scrub alloy residues is shown in **Figure C–12**. The process steps would be container bag-in, feed preparation for calcination, calcination, feed preparation for vitrification, and vitrification and bag-out. Nondestructive assay would also be performed, followed by final drum packaging and storage.

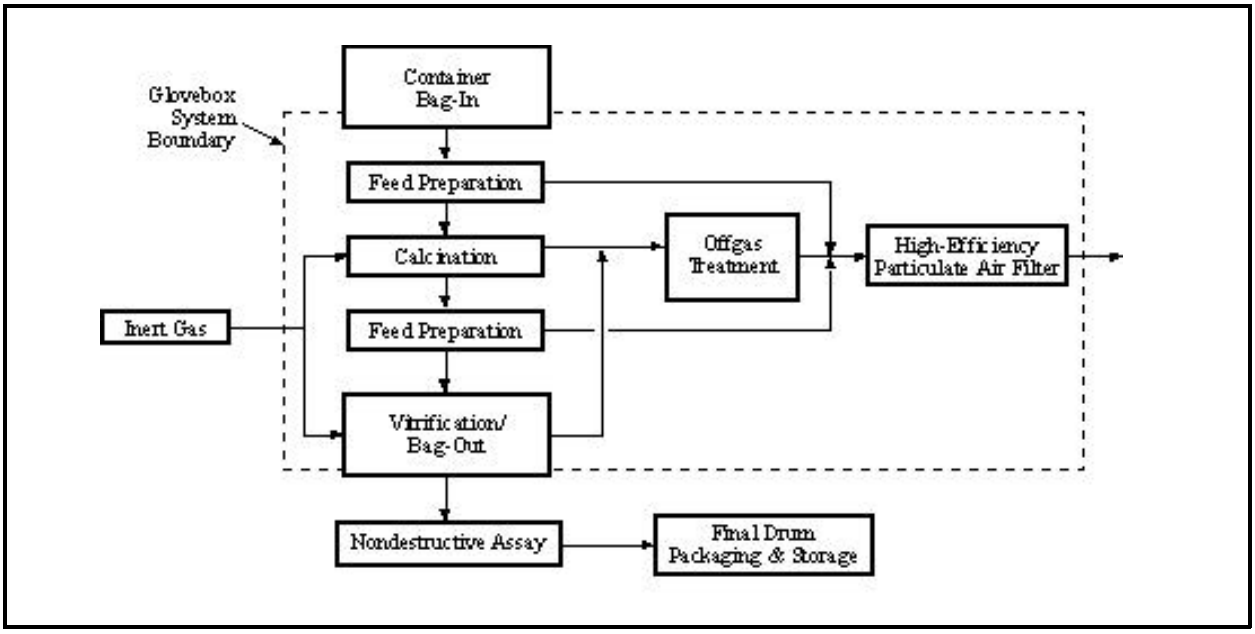


Figure C–12 Furnace Vitrification Process for Scrub Alloy

Furnace vitrification involves the addition of siliceous material called "frit" to the residues or scrub alloy followed by heating at 700 to 1,300°C (1,300 to 2,400°F) to produce a glass matrix. Two waste streams may be generated in addition to the vitrified product stream. The first waste stream would be a solid transuranic waste stream consisting of size-reduced stainless steel cans, plastic containers, plastic bags and containers. The second waste stream would be a gaseous effluent stream consisting primarily of one or more of the following, depending on the residue or scrub alloy type: nitrogen, oxygen, trace acid gases, carbon dioxide, nitrous oxide, water, and/or particulates. The off-gas stream would be configured to cool the effluents and remove acids and particulates before discharge into the glovebox exhaust high-efficiency particulate air filter system.

❒ **Detailed Process Description for Residues**

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure in Module D of Building 707. The contamination control enclosure would be designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox in Module E of Building 707. The containers, including outer bags, clamshells, and other packaging materials, would be removed from the drum and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox.

For the residues, after bag-in, the IDCs of residue containers/packages would be verified and the original residue packages would be transferred to a residue sorting and loading station or to a crushing station, either of which would provide local dust control. For most residue types, the sorting and loading station would contain a sieve to sort and to separate out oversized residue and tramp material (e.g., nuts, bolts). Tramp material and large pieces of residue would be collected on the sieve. The sieved residue fines would be collected in the new containers. The tramp material will be separated and transferred for transuranic waste size-reduction and packaging. Oversized residue pieces, would be sent through a size-reduction process and either mechanically crushed or shredded. Once size-reduced, the residues would be fed back to the

loading station. High-efficiency particulate air filter frames would be separated out and shredded for size-reduction and sorted glass residues would be crushed, then both will be loaded into new metal containers for the vitrification process. Sorted sludge residue materials would be loaded directly into a new metal container for the vitrification process.

The residues would be batched with an average of 83.5 g (2.9 oz) of plutonium per container. For all of the residues, following batching, a blending step would be required wherein the materials would be blended and diluted with low melting temperature frit. Each material stream to be immobilized by the vitrification process would be analyzed to determine the appropriate proportions of material and frit to meet the WIPP/Waste Acceptance Criteria requirements. The material containers would then be ready for vitrification.

After a container is charged and blended, it would be positioned into the heating chamber of the muffle furnace. The furnace would be energized and there would be a gradual ramp-up in temperature within the chamber. The temperature range for the vitrification process would be between 700 and 1,300°C (1,300 and 2,400°F). The actual vitrification temperature would be determined for each specific type of residue before vitrification.

Engineering investigations are underway to identify the most effective method to extract and capture the off-gases generated by the heating process. Various constituents may be generated during vitrification depending on the residue type, including one or more of the following: water vapor, carbon dioxide, nitrous oxide, trace quantities of acid gases, organic, and/or particulates. This description assumes the use of a dry scrubber using potassium carbonate for off-gas treatment. A concern with residual organic contaminants in the residue feed stream subsequently volatilizing during the heating process necessitated an investigation into the incorporation of a design modification which would continuously purge the heating chamber with inert gas during the processing of the residues.

The heating process would be approximately 4 hours in duration. The container would be allowed to cool to 100°C (212°F) before removal from the furnace. After final cooling, the container would be sealed with a lid and bagged out of the glovebox for nondestructive assay.

Post-vitrification nondestructive assay would be performed on all material containers to determine the amount of fissile material present. Following nondestructive assay, residue containers that meet the WIPP/Waste Acceptance Criteria fissile material limits would be transferred into Module F of Building 707 for final drum packaging. Two containers would be loaded into a pipe component staged inside a 208-L (55-gal) drum. The sealed drums would be placed into interim site storage awaiting shipment to WIPP.

❒ Detailed Process Description for Scrub Alloy

Stainless steel containers of scrub alloy would be transferred from storage and bagged directly into the glovebox. After bag-in, the alloy buttons would be unpacked and placed in a burn boat in a muffle furnace and calcined at approximately 600°C (1,100°F) for 2 hours to convert the scrub alloy to an oxide. After cooling, the powdery oxide would be transferred to another muffle furnace and calcined at 1,000°C (1,800°F) for 2 hours. After being allowed to cool, the boats would be transferred to the loading station. At this point in the process, oversized scrub alloy pieces would be sent back through the calcination process and transferred again to the loading station.

The scrub alloy would be batched to average 18.1 g (0.64 oz) of plutonium per container. Following batching, a blending step would be required wherein the materials would be blended and diluted with low-

melting-temperature frit. The material stream to be immobilized by the vitrification process would be analyzed to determine the appropriate proportions of material and frit to meet the WIPP/Waste Acceptance Criteria requirements. The material containers would then be ready for vitrification.

After a container is charged and blended, it would be positioned into the heating chamber of the muffle furnace. The furnace would be energized and there would be a gradual ramp-up in temperature within the chamber. The temperature range for the vitrification process would be between 700 and 1,300°C (1,300 and 2,400°F). The actual vitrification temperature would be determined for each specific type of material before vitrification.

Engineering investigations are underway to identify the most effective method to extract and capture the off-gases generated by the heating process. This description assumes the use of a dry scrubber using potassium carbonate for off-gas treatment. A concern with residual organic contaminants in the feed stream subsequently volatilizing during the heating process necessitated an investigation into the incorporation of a design modification that would continuously purge the heating chamber with inert gas during the processing of the scrub alloy.

The heating process would be approximately 4 hours in duration. The container would be allowed to cool to 100°C (212°F) before removal from the furnace. After final cooling, the container would be sealed with a lid and bagged out of the glovebox for nondestructive assay.

Post vitrification nondestructive assay would be performed on all material containers to determine the amount of fissile material present. Following nondestructive assay, containers that meet the WIPP/Waste Acceptance Criteria fissile material limits would be transferred into Module F of Building 707 for final drum packaging. Two containers would be loaded into a pipe component staged inside a 208-L (55-gal) drum. The sealed drums would be placed into interim site storage awaiting shipment to WIPP.

C.5.2 Immobilization (Cementation) of Graphite Residues

The proposed cement-based immobilization process is an adaptation of a Portland cement-based waste immobilization process that has been used within DOE and the commercial nuclear industry. This process was approved by EPA as a best demonstrated available technology for use in waste stabilization. At Rocky Flats, cement-based waste immobilization processes have been operated successfully for several years and have produced thousands of cubic yards of solidified waste. The process has been used for the solidification of low-level waste (saltcrete) in Building 374 and for the solidification of transuranic waste in Building 774 (bottlebox process). The graphite residue cement solidification process would be located in either Building 707 or Building 371 and would involve the cementation of graphite molds, scarfed graphite molds, coarse graphite, and coarse firebrick as feed materials.

Cementation of materials necessary to immobilize fines and to form an acceptable solid is considered to be a proven technology, although optimization studies are routinely performed to improve specific characteristics. Rocky Flats would have to install or remodel gloveboxes to provide additional area for the curing step, so approximately one year would be required after the issuance of the Record of Decision before the cementation capability would be fully operational. The specific location of the cementation processing is uncertain, although the process would be consistent with either Building 371 or Building 707.

The cement-based immobilization process is shown in **Figure C–13**. The process steps are drum unloading and bag-in, feed preparation for calcination, calcination, feed preparation for cementation, in-line nondestructive assay, process mixing, curing and bag-out, and final drum packaging and storage.

Cement-based immobilization blends cement and water with the prepared graphite residues. The advantage of cement-based immobilization technology is its proven performance. When well-established protocols are followed, a WIPP acceptable final product would be ensured. Elements included within these protocols include waste characterization, both physical and chemical; treatability formula development; bench scale testing; pilot scale studies; and detailed project planning for full-scale operations.

There are several disadvantages associated with a cement-based immobilization process. First, unrecognized variability in the waste feed stream can compromise the acceptability of the final product in meeting the WIPP/Waste Acceptance Criteria. Second, the mixing of the cement and water components produces heat during the curing process, and the active metals in the waste stream react with water to produce hydrogen gas. Third, during mixing, curing, and after final packaging, there is a potential for hydrogen generation due to both radiolysis and hydrolysis of the water of hydration by the radiological and reactive metal components, respectively. This allows for less transuranic material to be transported per shipment to WIPP.

In addition to the cemented-residue product stream, there would be two waste streams generated. The first waste stream would be a solid transuranic waste stream consisting of size-reduced steel containers, plastic containers and plastic bags. The second waste stream would be a gaseous effluent stream consisting primarily of nitrogen, water vapor, carbon dioxide, hydrogen, and particulates. Any tramp material removed from the waste would be either combined with the solid transuranic waste stream or placed into a cemented waste container before curing.

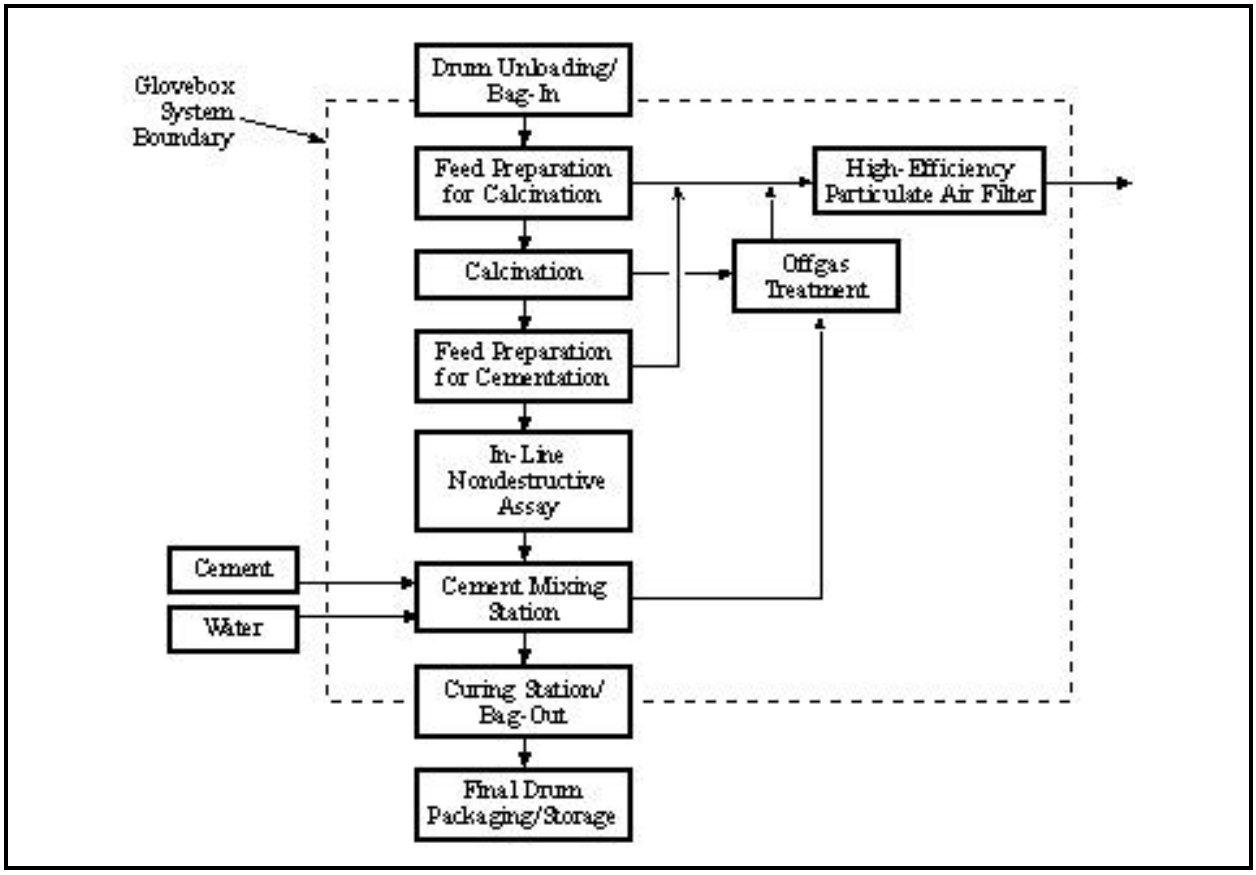


Figure C–13 Cement-Based Immobilization Process for Graphite Residues

❒ **Detailed Process Description**

Drums with the capacity of 208-L (55-gal) would be transferred from storage into a contamination control enclosure. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox. The containers, including outer bags, clamshells and other packaging materials, would be removed from the drum and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag before transfer to the glovebox. There would be approximately five containers in each drum.

After bag-in, the IDCs of the residue containers would be verified and the original residue containers would be transferred either to a residue sorting and loading station or, for the large sized residue such as graphite molds, directly to a crusher. Both the sorting and loading station and crusher would provide local dust control. The sorting and loading station would contain a 0.32-cm (1/8-in) sieve that would be used to separate oversized residue and tramp material (e.g., nuts, bolts). The sieved residue fines would be transferred into burn boats. Tramp material would be separated and transferred for transuranic waste size reduction and packaging or placed into the cemented waste before curing. Oversized residues would be crushed and fed back to the loading station. Each container would be filled to contain approximately 83.5 g (2.9 oz) of plutonium. After the filling step, the burn boats would be transferred to the muffle furnace for calcination.

Calcination is required to high-fire the residue, which would remove the reactive characteristics in the residue stream. Each batch would be calcined at 900°C (1,650°F) for 4 hours, which would oxidize carbon and organic to carbon dioxide and eliminate water, thereby increasing the bulk density of the residue. After cooling, the residue would be transferred for feed preparation for cementation.

The burn boats containing the calcined residue would be transferred to a residue sorting and loading station. As described previously, the residue will be sieved and the residue fines would be loaded into metal containers. As required, oversized residues would be crushed and loaded into the containers. Each container would be filled to contain approximately 83.5 g (2.9 oz) of plutonium. After the container filling step, the containers would be transferred to an in-line nondestructive assay station.

Nondestructive assay would be performed, after which, the container would be moved to the mixing station. Then, measured quantities of water and cement would be manually blended into the residue containers. The material would be mixed until all of the water has been absorbed by the cement and the mixture thickens. Because of the potential for heat generation, provisions for actively cooling the container during and after mixing may be required for certain residue IDCs. During mixing, there is a potential for vapor generation produced by an exothermic reaction associated with the hydration of the cement and through hydrogen gas generation produced from radiolysis and hydrolysis. Therefore, provisions would be incorporated as necessary for the collection and extraction of these vapors in both the mixing station and curing station. The container would then be removed from the mixing station into a set of curing gloveboxes and set aside for a 24-hour curing period. After curing has been completed, the cans would be bagged out of the glovebox.

Assayed, cemented residue containers that meet the WIPP/Waste Acceptance Criteria would be transferred for final drum packaging. Two containers would be loaded into a pipe component already staged inside of a 208-L (55-gal) drum. The sealed drums would be placed into interim site storage awaiting shipment to WIPP.

C.5.3 Blend Down

Blend down technology would involve mixing residues with other materials to reduce plutonium concentrations below safeguards termination limits. The blending process would be conducted inside a glovebox located in Module E of Building 707 for all residues except salts or in Room 3701 of Building 371. Uranium oxide and other nonradioactive materials, such as magnesium oxide sand, have been proposed as the blending diluent. Most uranium oxide currently at Rocky Flats has been classified as Resource Conservation and Recovery Act hazardous waste and a decision on its use must be made. Uranium oxide imported from another site, such as Savannah River Site, may be required.

Blending of granular or powdered residue materials with inert or lower-assay powdered residues, and the subsequent packaging and assaying, is considered to be a proven technology. Capabilities necessary to satisfy all alternatives are being installed at Rocky Flats as part of the ongoing stabilization programs, and should be operational within several months of issuance of the EIS. The specific location of the blending process is uncertain, although the process would be consistent with either Building 371 or Building 707.

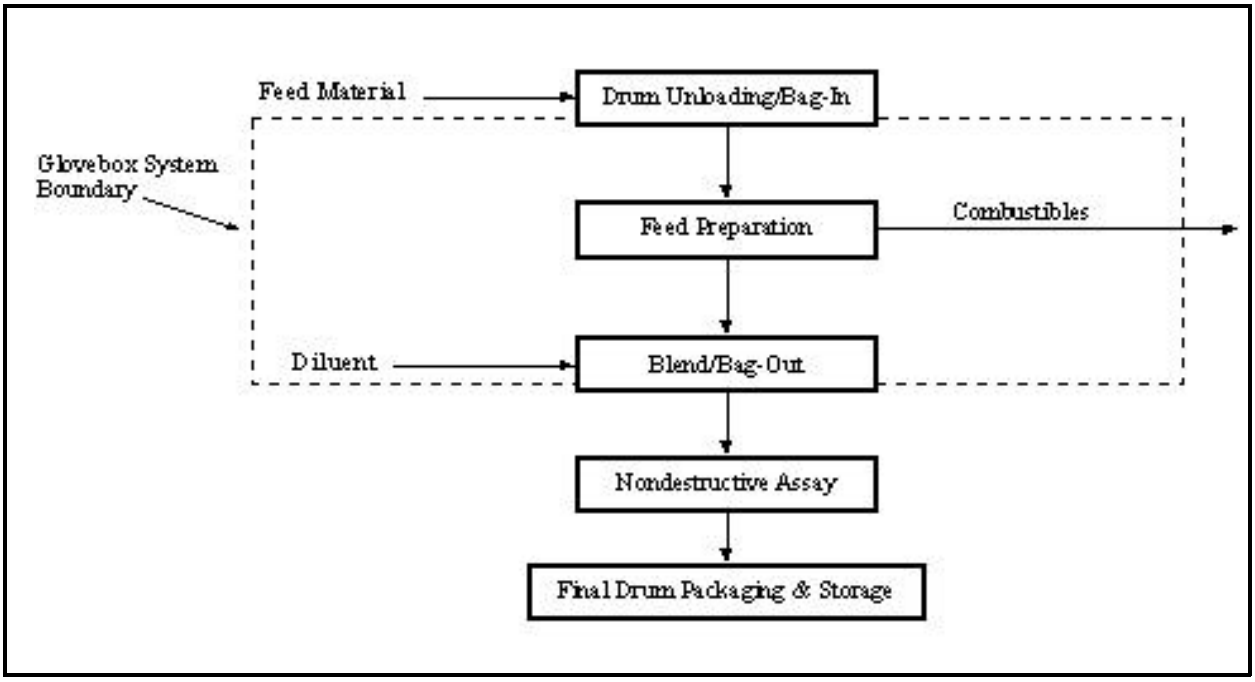


Figure C–14 Blend Down Process for All Residues Except Salts

The blend down process for all residues is shown in **Figure C–14**. For most of the residues, the feed materials would be sorted and size-reduced to enhance uniform mixing with the diluent. Calcination would be required for ash residues (except for graphite fines) in order to convert reactive metals to unreactive oxides and to meet the high-fired qualification. The feed materials would then be blended with the diluent. For plutonium fluorides, the feed materials would be unpacked and then blended with the diluent without size reduction. The packaged residue product for each residue would be removed from the glovebox, nondestructively assayed for accountability purposes, packaged in the final transport/storage container, and placed in interim storage.

❒ **Detailed Process Description**

Drums and containers would be manually transferred from storage into a contamination control enclosure and examined for damage. The contamination control enclosure is designed to control airflow in the event of damage or a bag failure within a drum or container. The drum or container would be opened and the

integrity of the packaging would be checked. If the packaging has not been compromised, the drum/container would be transferred to the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox. If the integrity of the packaging has been compromised, the packaging would be overpacked with a new plastic bag before transfer to the glovebox. All individual drums/containers would be bagged into the feed preparation glovebox.

For most residues, the feed would be introduced into the glovebox, the IDC verified, and each package/bag would be opened and sorted/sieved to remove any tramp metal and other unwanted materials. Following the sorting/sieving, combustible and filter media residue feed materials would be shredded, and ash, sludge, glass, graphite, and inorganic residue feed materials would be crushed and sieved to produce a particle size for uniform mixing with the blending diluent. The crushed feed would again be sieved with a finer mesh screen and any large chunks will be returned to the crusher for reprocessing. Both the shredded and crushed materials would then be batched so that each new container will average 83.5 g (2.9 oz) of plutonium, except sand, slag, and crucible, which would be batched to 18.1 g (0.64 oz) of plutonium because of the high ratio of diluent to residue matrix required. Calcination would be required to high-fire the incinerator ash residues and firebrick fines. It may also be required for certain feeds, such as sand, slag, and crucible, with reactive characteristics. Further study must be completed to ensure that dilution of the feed will negate reactivity characteristics in the feed streams. Each batch would be calcined at 900°C (1,650°F), which would oxidize carbon and organic materials to carbon dioxide and eliminate water, and increase the bulk density of the ash residues. Crushing may be required after calcination. After crushing, the batches would be available for blending.

For plutonium fluorides, the materials would be removed directly from containers and would be batched so each new container would average 18.1 g (0.64 oz) of plutonium, due to its high ratio of diluent to residue matrix. It would be necessary to batch the fluorides with 18.1 g (0.64 oz) plutonium per package to maintain the final package weight at less than 9 kg (20 lb) to allow for physical handling within the glovebox. The batching used for each residue would allow for maximum packaging flexibility during the final packaging step after nondestructive assay has been completed and accountability data has been analyzed. Combustible packaging materials from the individual containers would be bagged out of the glovebox and sent to a combustible handling process. Any metals or other unwanted materials would be bagged out of the glovebox and managed appropriately.

Blending may be done manually or mechanically using a blender. In either case, blending would be a hands-on operation, whether the addition of the diluent to the batched feed and subsequent mixing would be accomplished in small batches manually or whether loading and unloading steps must be accomplished for use of a mechanical blender. If Rocky Flats uranium oxide is used as the diluent, it would be calcined and sieved in another location to convert it to a uniformly sized powdery oxide form. If uranium oxide is imported from the Savannah River Site, this step would not be necessary. Additional or different stabilization processings may be needed if salt, magnesium oxide sand, or other blending material is used as a diluent instead of, or in addition to, uranium oxide. This would ensure that the diluent material, when added to the crushed and sieved feed materials, would blend uniformly. The blended material would then be bagged from the glovebox and placed in a convenience container for safe handling.

Nondestructive assay would be performed to ensure requirement limits are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data are obtained. Assayed product packages would be selected for final packaging to minimize the number of shipping containers required to be shipped to WIPP. Selected

packages would be loaded into an inner container and sealed before placing of the container into the final outer shipping container.

C.5.4 Pyro-Oxidation and Blend Down of Pyrochemical Salts

The pyro-oxidation and blend down process would remove reactive metals from the salts and mixes them with a matrix to reduce the plutonium concentration to below the safeguards termination limit for pyrochemical salts. This technology can be used on electrorefining salts, molten salt extraction salts, and direct oxide reduction salts. The pyro-oxidation and blending processes would be conducted inside gloveboxes located in Module E of Building 707 or in Room 3701 of Building 371. Uranium oxide and other nonradioactive materials, such as magnesium oxide sand, have been proposed as the blending diluent. Most uranium oxide currently at Rocky Flats has been classified as Resource Conservation and Recovery Act hazardous waste and a decision on its use must be made. Uranium oxide imported from another site, such as the Savannah River Site, may be required.

Pyro-oxidation of salts in stationary furnaces is considered to be a proven technology, although specific process variables are being evaluated in an attempt to make the pyro-oxidation process more compatible with a pyro-distillation follow-on processing step. Pyro-oxidation of reactive salts is part of the Rocky Flats response to Defense Nuclear Facilities Safety Board Recommendation 94-1 to stabilize potentially higher-risk or reactive materials. Rocky Flats has the capability to support the ongoing stabilization programs, and operations are pending. While not a technology risk for the pyro-oxidation process, the salts, once pyro-oxidized, cannot be subsequently salt scrubbed, which is the only current process to allow plutonium separation using the Purex process. The on-going stabilization program trades the technical and programmatic risk of not using a proven Savannah River Site residue disposition approach (Purex) against the reduction of an immediate safety risk. The pyro-oxidation process is, however, a prerequisite step for both salt distillation and aqueous distillation. Blending of granular or powdered residue materials with inert or lower-assay powdered residues, and the subsequent packaging and assaying, is considered to be a proven technology. Capabilities necessary to satisfy all alternatives are being installed at Rocky Flats as part of the ongoing stabilization programs, and should be operational within several months of issuance of the EIS. The specific location of the blending process is uncertain, although the process would be consistent with either Building 371 or Building 707.

The pyro-oxidation and blending process steps for pyrochemical salt residues are shown in **Figure C–15**. The salt residues would be sorted and batched in preparation for pyro-oxidation. The salts would be pyro-oxidized to convert reactive metals to oxides. After pyro-oxidation, the oxidized salts and plutonium oxide would be size-reduced. They would then be blended with the diluent. The packaged product would be removed from t h e

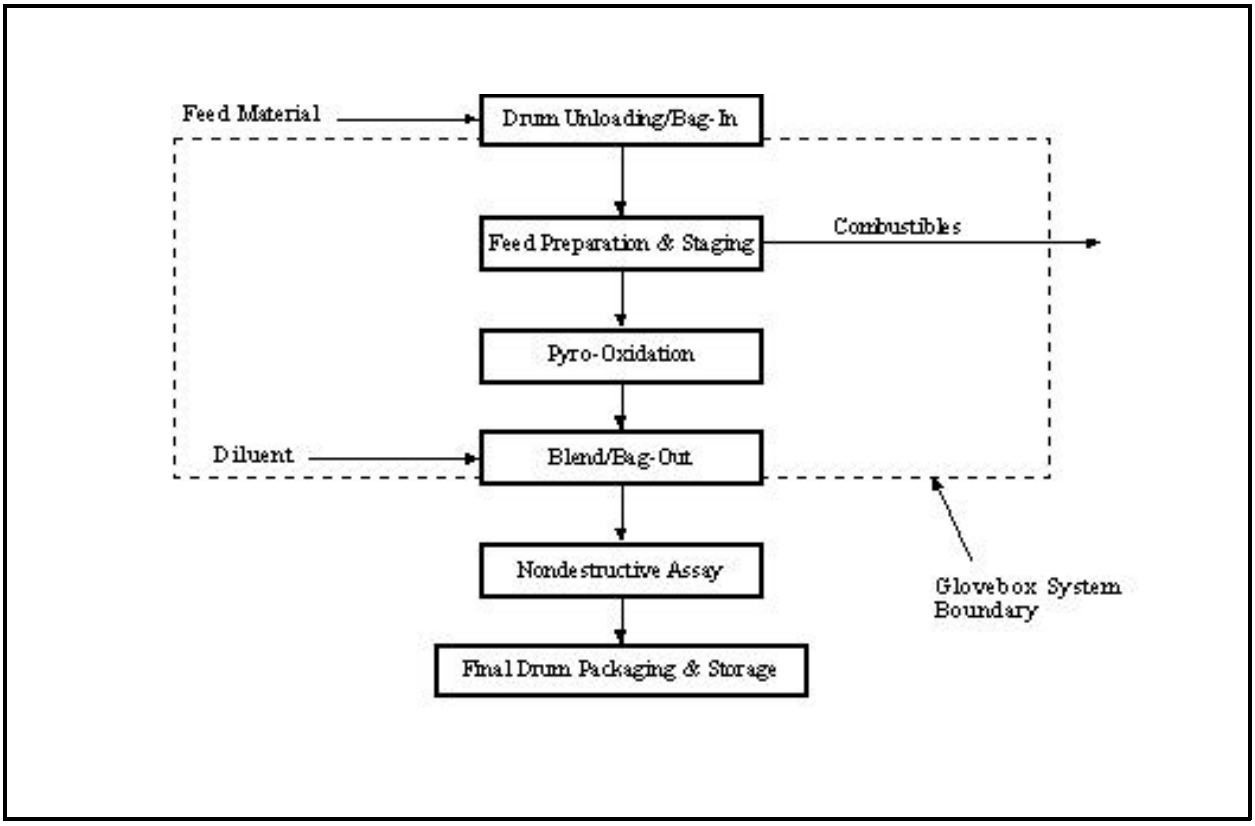


Figure C–15 Pyro-Oxidation and Blend Down Process for Pyrochemical Salt Residues

glovebox and nondestructively assayed for accountability purposes, packaged in the final transport/storage container, and placed in interim storage.

❒ Detailed Process Description

As required, drums would be manually transferred from storage into a contamination control enclosure. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drum would be opened and the integrity of the packaging will be checked. If the packaging has not been compromised, the containers would be transferred to the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the salt feed preparation glovebox. If the integrity of the packaging has been compromised, the packaging would be overpacked with a new plastic bag before transfer to the glovebox.

The salts would be introduced into the glovebox, one package at a time, and the IDC verified. The individual packages would be opened and loaded into a magnesium oxide crucible in preparation for pyro-oxidation. Combustible packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustible handling process. Other materials would be bagged out and managed appropriately.

Once the crucible is loaded with salt feed, it would be placed in a glovebox furnace and heated to approximately 800°C (1,500°F) with an oxidant, such as sodium carbonate, as a reagent for 2 hours, stirring continuously. The product would be a lower plutonium-bearing salt matrix on top and plutonium oxide bound in a salt matrix at the bottom of the crucible. Pyro-oxidation could be applied to both sodium

chloride-potassium chloride and calcium chloride matrices. This process converts reactive metals (calcium and sodium) to oxides. Stirring is discontinued during the cooling phase. When the furnace has cooled to below 100°C (212°F), the crucible would be removed from the furnace. During the heating, stirring, and cooling phases, argon would flow through the furnace. During the last part of the stirring phase, argon would be replaced by a mixture of air and argon.

Once the crucible is removed from the furnace, it would be allowed to completely cool before breakout. The salt matrix and plutonium oxide would then be removed from the crucible. The crucible would be discarded and treated as inorganic ash residue. At this point, the salt matrix and plutonium oxide would be screened and sent through a crusher in order to achieve a uniform size for blending with diluent, and placed in containers in preparation for blending. After the materials are size-reduced, they would be batched to 18.1 g (0.64 oz) or less of plutonium due to the high ratio of diluent to residue matrix required. This would allow for maximum packaging flexibility during the final packaging step after nondestructive assay has been completed and accountability data has been analyzed.

Blending may be done manually or mechanically using a blender. In either case, blending would be a hands-on operation, whether the addition of the diluent to the batched feed and subsequent mixing is accomplished in small batches manually or whether loading and unloading steps must be accomplished for use of a mechanical blender. If Rocky Flats uranium oxide is to be used as the diluent, it would be calcined and sieved in another location to convert it to a uniformly-sized powdery oxide form. If uranium oxide is imported from the Savannah River Site, this step would not be necessary. Additional or different stabilization processings may be needed if salt, magnesium oxide sand, or other blending material is used as a diluent instead of, or in addition to, uranium oxide. This would ensure that the diluent material, when added to the crushed and sieved feed materials, would blend uniformly. The blended material would then be bagged from the glovebox and placed in a convenience container for safe handling.

Nondestructive assay would be performed to ensure requirement limits are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data are obtained. Assayed product packages would be selected for final packaging to minimize the number of shipping containers required to be shipped to WIPP. Selected packages would be loaded into an inner container and sealed before placing the container into the final outer shipping container.

C.5.5 Sonic Wash

Sonic washing for combustible, filter media, glass, and inorganic residues removes the organic and nitrate contaminants from the residue waste to eliminate the potential flammable hazard and allow for its disposal at WIPP. Along with nitrate removal, the sonic wash process may remove up to 90 percent of the plutonium from the residue waste (up to 99 percent for glass residues). At this removal efficiency, the waste would meet safeguards termination limits for disposal at WIPP. The plutonium and nitrate removed from the residues would be vitrified to meet the safeguards termination limit for vitrified waste disposal at WIPP. The sonic washing process would be conducted inside a glovebox located in Room 3701 of Building 371.

Sonic washing of materials, using sound waves to enhance the partition of a residue into a below-safeguards termination limit (washed) component and a concentrated component which would then be vitrified to meet safeguards termination limit, has been demonstrated with residue-type materials on a bench scale. Due to the significant effort required to demonstrate a consistent process and develop the procedures and analysis necessary for routine operation, the estimated time required to deploy this operation would be 2 years after the issuance of the Record of Decision.

The sonic washing process for residues is shown in **Figure C–16**. The process steps include drum unloading and package bag-in, feed preparation, thermal desorption and steam passivation (for combustible and filter media residues), sonic washing and decant/filtration, evaporation and water recycle, plutonium vitrification and package bag-out, and oven drying and package bag-out. Nondestructive assay would be performed, followed by final drum packaging and storage.

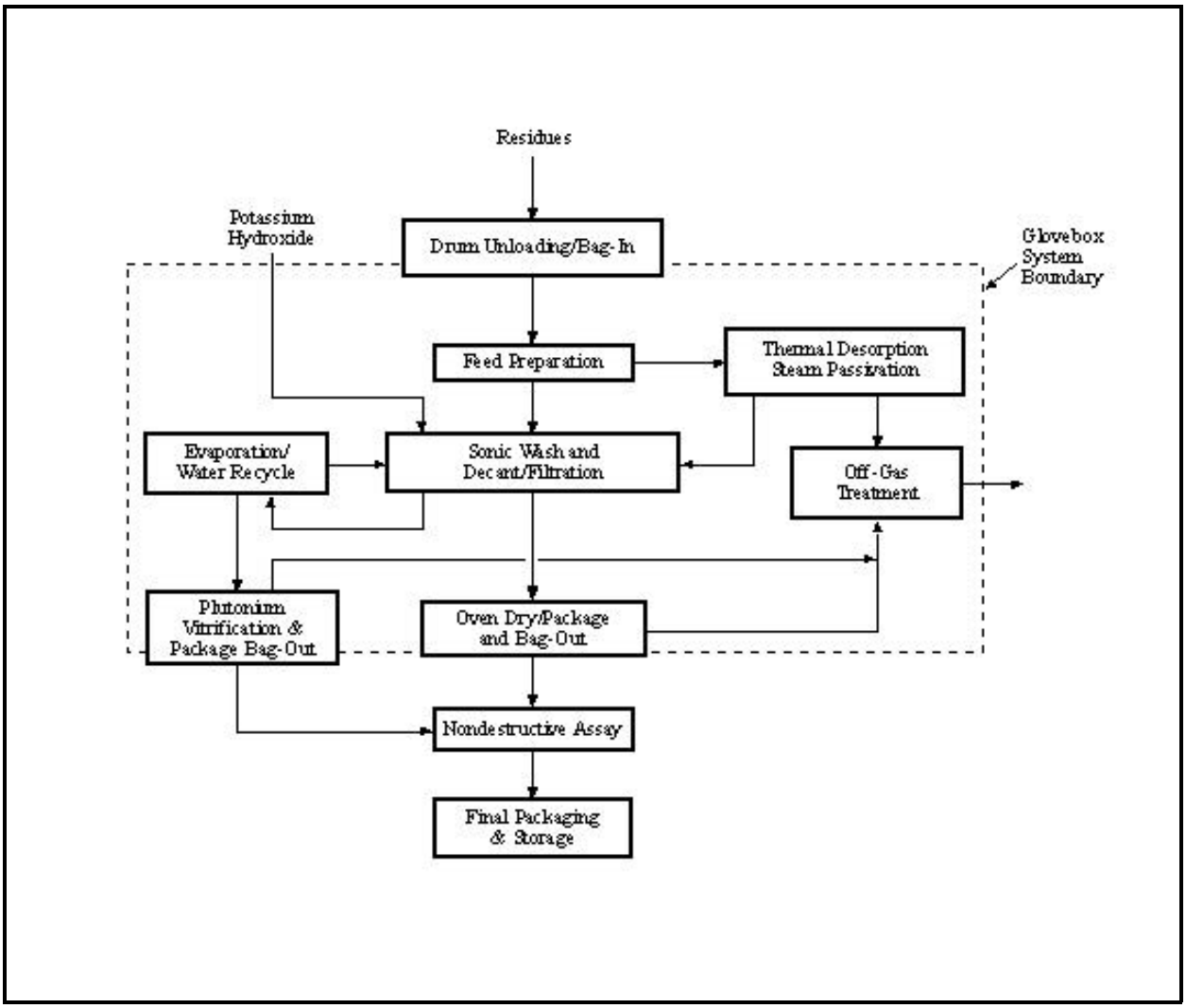


Figure C–16 Sonic Wash Process

❒ Detailed Process Description

Drums would be manually transferred into a contamination control enclosure and unpacked. The contamination enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging will be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag

before transfer to the glovebox. Each of the individual bags would be bagged into the feed preparation glovebox.

The residue feed would be introduced into the glovebox and the IDC verified. Each bag would be opened to remove any tramp metal and other unwanted materials, and sorted to separate the organic contaminated residues from the nonorganic contaminated residues. Following the sorting, the feed materials would be shredded and batched to 5 kg (11 lb) of residue in preparation for low temperature thermal desorption and sonic washing. Any metals and other unwanted materials would be bagged out of the glovebox and managed appropriately.

The organic contaminated residues would be fed in 5 kg (11 lb) batches to a low temperature thermal desorption unit which operates under a vacuum at 80°C (176°F). During the 6-hour process, the organic contamination would be volatilized from the residues. The organic containing off-gas would be treated by silent discharge plasma destruction before being vented through a high-efficiency particulate air filter. The resulting residues would then be sonic washed.

Sonic washing would be intended to remove both the nitrate and plutonium contamination from the residue waste to meet acceptable waste storage criteria at WIPP. The 5-kg (11-lb) batches of residue from feed preparation would be sonic washed with 50 L (13-gal) of aqueous solution containing 10 percent excess potassium hydroxide to neutralize any residual nitric acid contained within the waste. After 2 hours of sonic washing, the acid would be neutralized forming potassium nitrate and water, and approximately 90 percent of the plutonium would be removed from the residue waste (and 99 percent of the plutonium from glass residues). The residue solids would be separated from the nitrate and plutonium-containing solution by decanting and filtration. The solids would be transferred to a drying pan. The solution from sonic washing would contain approximately 90 percent of the plutonium, as solids, and more than 97 percent of the nitrates, which are dissolved. This solution would flow to the evaporation and recycle step.

The nitrate and plutonium bearing solution would be evaporated in a forced circulation evaporator to produce water which may be recycled to the sonic washing step, and dried nitrate and plutonium solids. While the evaporator type has not yet been selected, it would evaporate approximately 50 L (13 -gal) of water within a 3-hour period, and would probably operate under a vacuum at a temperature below 100°C (212°F). This would require a heat load of approximately 40,000 Btu (11.7 kilowatts) per hour, and the capability of evaporating the liquid while preventing the collection of the plutonium on the heat transfer surface. After evaporation, the solids would be weighed into batches containing an average of 83.5 g (2.9 oz) plutonium and placed into 8.2-L (2.2-gal) containers in preparation for vitrification.

Following batching, a blending step would be required where the residue material would be blended and diluted with low-melting-temperature frit. Each residue stream to be immobilized by the vitrification process would be analyzed to determine the appropriate proportions of residue and frit to meet the WIPP/Waste Acceptance Criteria requirements. The residue containers would then be staged for vitrification. Once the residue container is charged and blended, it would be positioned into the heating chamber of the muffle furnace. The furnace would be energized and there will be a gradual ramp-up in temperature within the chamber. The target temperatures for vitrification would be between 700 and 1,300°C (1,300 and 2,400°F). The actual temperature would be determined for each specific type of residue before vitrification.

Engineering investigations are underway to identify the most effective method to extract and capture the off-gases generated by the heating process. Water vapor, carbon dioxide, nitrous oxide, trace quantities of acid gases, organic, and particulates may be generated during vitrification. This description assumes the use

of a dry scrubber using potassium carbonate for off-gas treatment. A concern with residual organic contaminants in the residue feed stream subsequently volatilizing during the heating process necessitated an investigation into the incorporation of a design modification which would continuously purge the heating chamber with inert gas during the processing of the residues.

The heating process would be approximately 4 hours in duration. The container would be allowed to cool to 100°C (212°F) before removal from the furnace. After final cooling, the container would be sealed with a lid and placed into a convenience can before being bagged out of the glovebox for nondestructive assay. The sonic wash technology would produce 8.2-L (2.2-gal) containers of vitrified plutonium/nitrate waste.

The sonic-washed residue waste would be transferred from sonic washing to the drying oven in drying pans. The waste would be dried under a vacuum at 80°C (176°F) for 2 hours, producing a dry waste (containing approximately 1 percent water). Off-gas from drying would be treated before high-efficiency particulate air filtration to capture or destroy any volatilized contaminants. After cooling, the waste would be weighed, and the quantity of plutonium estimated, as the waste is transferred to 8.2-L (2.2-gal) containers. These containers would be bagged out of the glovebox and packaged into convenience cans. Based on 90 percent of the plutonium being removed in the sonic wash, the plutonium remaining in the waste would be below the safeguards termination limit required for shipment and disposal at WIPP.

Nondestructive assay would be performed to ensure requirement limits are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data are obtained. Within this single step, 8.2-L (2.2-gal) waste containers from both plutonium vitrification with bagout and residue drying with bagout steps would be analyzed. Assayed product packages would be selected for final packaging from both the vitrified plutonium/nitrate waste and the dried residue waste to minimize the number of shipping containers required to be shipped to WIPP. Selected packages would be loaded into an inner container and sealed before placing the container into the final outer shipping container. The sonic wash technology would produce drums containing pipe components loaded with nitrate-washed combustibles and vitrified plutonium waste.

C.5.6 Catalytic Chemical Oxidation of Combustible Residues

The catalytic chemical oxidation process is a relatively new dissolution process that has been incorporated into a standard aqueous separation process for the processing of plutonium-containing residues. The catalytic chemical oxidation/aqueous process would be used to remove all of the plutonium from the residue matrix material, creating a concentrated plutonium oxide stream and converting the residual material into carbon dioxide and water. Catalytic chemical oxidation processing can be used on combustible residues, including wet and dry combustibles, plastic, and leaded gloves. The catalytic chemical oxidation process would principally be conducted inside gloveboxes located in Room 3701 of Building 371. The catalytic chemical oxidation process for combustible residues is shown in **Figure C–17**.

Catalytic chemical destruction of combustibles at elevated temperatures and pressures, while demonstrated in a commercial environment, is completely unproven as a production process in the size and service required, and for residue material applications. Due to the significant effort required to demonstrate a consistent process and to develop the procedures and analysis necessary for routine operation, the estimated time to deployment of this operation would be 4 years after the issuance of the Record of Decision.

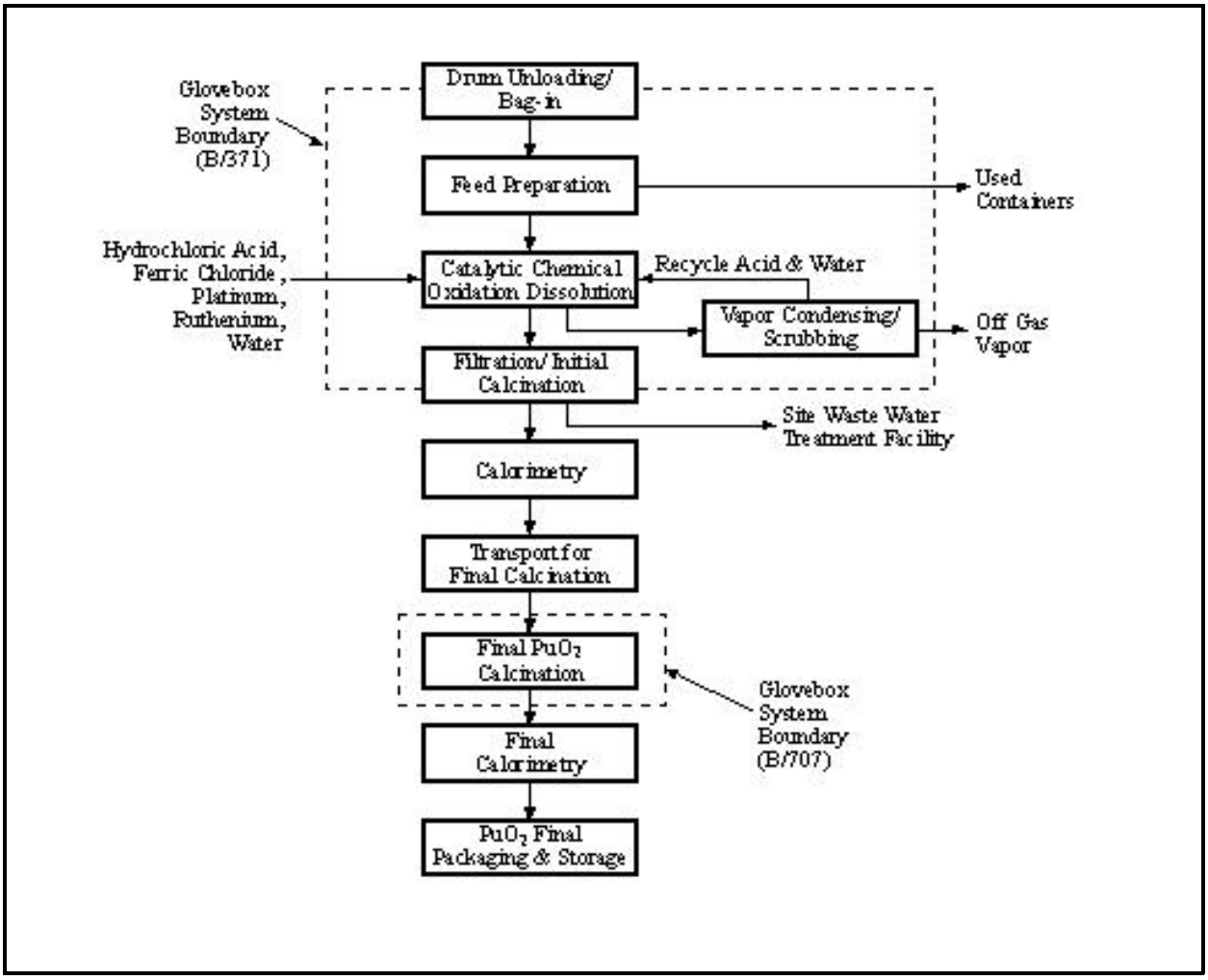


Figure C–17 Catalytic Chemical Oxidation Process for Combustible Residues

The catalytic chemical oxidation process is a dissolution process to separate plutonium from a residue using a catalyst to enhance the oxidation of liquid or solid organic materials, and dissolve metallic components of the residues. Catalytic chemical oxidation would utilize a hydrochloric acid solution at elevated temperatures and pressures that would maintain the solution below its boiling point. As the material is oxidized, the catalyst would be regenerated using injected oxygen. Once the plutonium species are dissolved and all of the combustible material is destroyed, the solution would be neutralized and the dissolved solids, including plutonium, would be precipitated as oxides. The resulting solids would be separated and treated for storage and shipment, and the liquids treated in the site wastewater treatment facility.

❒ Detailed Process Description

Drums would be manually transferred into a contamination control enclosure and unpacked. This step would contain any contamination which could result from an individual package containment damaged by radiolysis or other physical damage to the package during storage. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox.

After bag-in, the IDCs of the combustible residue containers would be verified. The original residue containers would be transferred to a residue sorting and loading station which would provide local dust

control and contain a sorting station to separate all oversized residue and tramp material. As the dissolver would only convert combustible residues, all other material would be sorted out and removed from the glovebox with the tramp material. The combustible residues would be shredded and weighed into dissolver feed containers. Each dissolver feed container would hold a 100-g (3.5-oz) charge of bulk shredded residue, each charge containing an average of 1.87 g (0.066 oz) of plutonium. The dissolver feed containers would be transferred to the dissolver glovebox as required.

The catalytic chemical oxidation dissolution step would consist of a 7.6-L (2-gal) catalytic chemical oxidation dissolver, a condenser for off-gas treatment, and piping and tankage to support the equipment. The process would be operated on a batch basis. First, the dissolver tank would be filled with 6M ferric chloride and 1M hydrochloric acid solution. Platinum and ruthenium would also be added from 0.001M solutions of each. The solution would be heated to 175 to 200°C (350 to 390°F) at a pressure of 60 to 110 pounds per square inch gauge (410 to 760 kilopascal gauge) to maintain the solution below boiling. The prepared residue would be fed into the heated solution at one 100-g (3.5-oz) residue charge per hour, and would be agitated to maintain the solution in contact with the solid particles. As each dissolution charge would take 2 hours of active dissolution time, an additional 100-g (3.5-oz) residue charge would be fed to the dissolver every hour until the dissolver contains 100 g (3.5 oz) of plutonium. Each 100-g (3.5-oz) plutonium batch would require approximately 54 100-g (3.5-oz) residue charges. Once the dissolver would contain 100 g (3.5 oz) of plutonium, no further charges would be added to the dissolver. Heat and oxygen would continue to be applied to the unit for an additional hour to vaporize all of the acid and neutralize the solution. As the acid is removed from the solution, the dissolved metals would precipitate as oxides. The solution would be cooled and the slurry pumped from the dissolver to a filter holding tank. All of the carbonaceous materials in the residue feed would be oxidized to carbon dioxide and water.

The slurry would be drained from the filter holding tank into stainless steel filter boats with a sintered metal filter. The liquids would be sucked through the filter, leaving the solid metal precipitate material within the filter boat. The filtrate would be collected and sent to the site wastewater treatment facility. These filter solids would include the plutonium, the iron precipitated from the ferric chloride reagent, platinum and ruthenium catalysts, and any other trace metals dissolved and precipitated during the catalytic chemical oxidation reaction. The filter boats would be placed in a calciner and heated to approximately 400°C (750°F) for an hour to convert the plutonium and metal precipitates to plutonium and metal oxides and carbon dioxide. The plutonium oxide would then be consolidated into slip-lid cans, weighed, and bagged out of the glovebox. The package would be loaded into a convenience can, as necessary, before being nondestructively assayed and transported to Building 707 for final calcination.

The plutonium oxide package would be assayed for plutonium content based on its rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be ready for storage. This activity is required to maintain accountability within the catalytic chemical oxidation material balance area. The cans containing the plutonium oxide would be placed in appropriate outer containers and transferred to the Building 371 loading dock. The containers would then be transported to the Building 707 loading dock by intra-site truck transportation, and moved to appropriate vault storage pending final calcination.

The plutonium oxide cans would be transferred from the Building 707 storage vault to Module J and bagged into the plutonium stabilization and packaging system. The plutonium oxide would be removed from the cans and placed in furnaces, and calcined at 1,000°C (1,800°F) for 4 hours. The material, now suitable for long-term storage or transportation, would be weighed, characterized, and placed in a 3013 inner container. This container would then be removed from the glovebox via the bagless transfer process and sent to calorimetry. The plutonium oxide package would be assayed for plutonium content based on its rate

of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be placed in vault storage pending DOE decisions on eventual disposition of the plutonium.

The vapors produced during the catalytic chemical oxidation process would be condensed to recover the majority of the acid and water volatilized during the reaction. The condensed acid and water would be returned to a catalytic chemical oxidation feed tank where the amount of acid contained would be determined so the appropriate quantity of recycle and fresh acid could be added to the subsequent catalytic chemical oxidation batch dissolution. The vapor from the condenser would be scrubbed to further reduce the quantity of acid and water contained in the discharge vapor.

C.5.7 Cold Ceramification for Ash Residues

The Cold Ceramification Process would stabilize the waste stream by converting chemical wastes and contaminated materials into chemically bonded phosphate ceramics. The waste stream would be mixed with reagents such as magnesium oxide and monopotassium phosphate to produce low temperature chemical reactions that would yield a ceramic material in which the hazardous constituents would be both physically encapsulated and chemically bonded. The ceramics produced would be dense, highly leach resistant, impermeable and very strong. The equipment required for cold ceramification is similar to the equipment used in current cement stabilization processes.

The cold ceramification process would blend magnesium oxide powder and monopotassium phosphate powder with the prepared ash residue, then would mix this blend with water to produce a low temperature chemical reaction. This chemical reaction would yield a dense, impermeable and highly leach resistant ceramic material that would encapsulate the contaminants. Due to the densification that occurs during the process and the high waste loadings, the final waste volume would typically be less than that of conventional treatment processes. Additional advantages of cold ceramification technology are its insensitivity to pH, lack of impact on the binding process from salts in high concentrations, and negligible hydrogen release from the final waste form.

In addition to the ceramic encapsulated residue product stream, there would be two waste streams generated. The first waste stream would be a solid transuranic waste stream consisting of size-reduced steel containers, plastic containers, and plastic bags. The second waste stream would be a gaseous effluent stream consisting primarily of water vapor, nitrogen, hydrogen, carbon dioxide, and particulates. Any tramp material removed from the waste prior to size reduction would be combined with the solid transuranic waste stream.

The cold ceramification process for Ash Residue would be located in Building 371. It is an in-container treatment process that encapsulates all Ash Residues to meet the safeguards termination limit for disposal at WIPP.

The cold ceramification process is shown in **Figure C-18**. The process steps would include drum unloading and bag-in, feed preparation, in-line nondestructive assay, ceramic mixing station, curing and bag-out, and final drum packaging and storage.

❒ Detailed Process Description

Upon demand, 208-L (55-gal) drums would be transferred from storage into a contamination control enclosure. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox. The containers, including outer

bags, clamshells, and other packaging materials, would be removed from the drum and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag, prior to transfer to the glovebox.

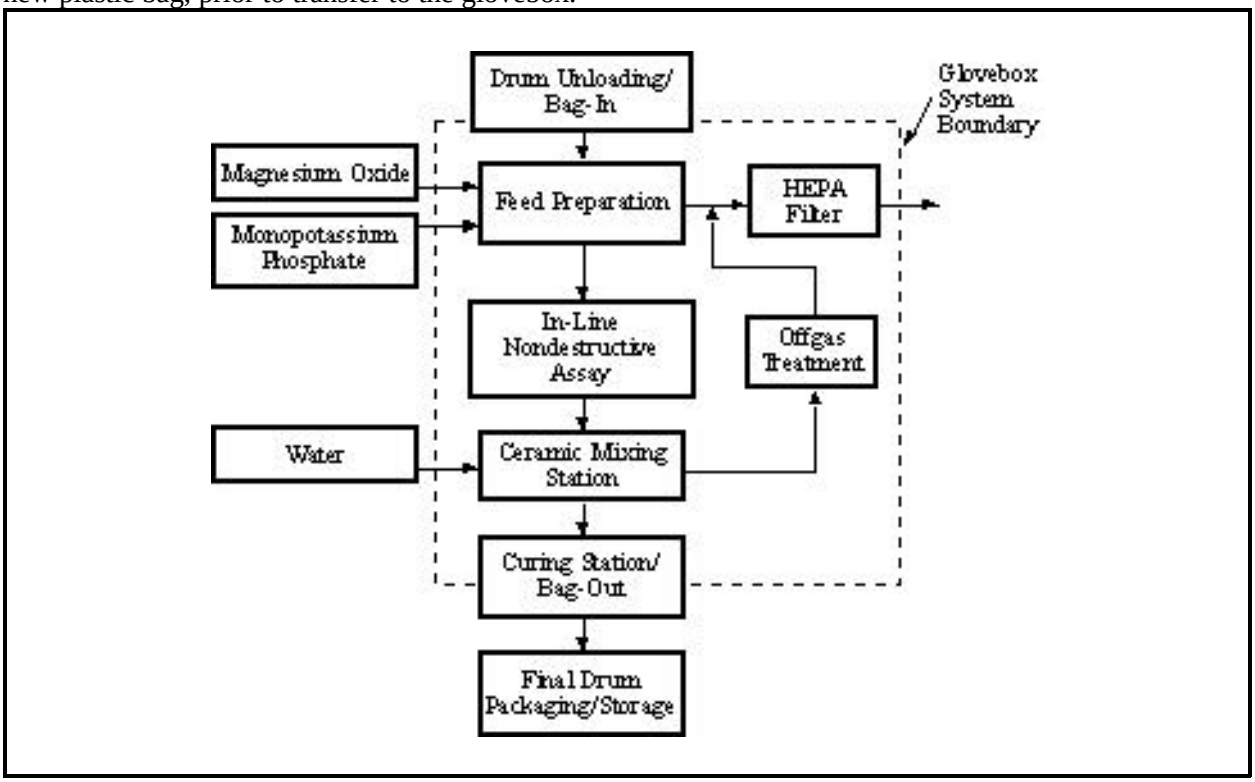


Figure C–18 Cold Ceramification Process for Ash Residues

After bag-in, the IDCs of the ash residue containers would be verified. Then, the original residue containers would be transferred to a residue sorting and loading station. This loading station would provide local dust control and would contain a 0.318 cm (0.125 in) sieve that would be used to separate all oversized residue and tramp material (nuts, bolts, etc.). The sieved residue fines would be transferred into 4-L (1.06-gal) metal containers. Tramp material would be separated and transferred for transuranic waste size reduction and packaging. Oversized residue would be crushed and fed back to the loading station for sieving. Each container would be filled to contain approximately 83.5 g (2.9 oz) of plutonium. Then, the magnesium oxide and monopotassium phosphate would be blended into the container with the residue. After the blending step, the containers would be transferred to an in-line nondestructive assay station.

Following the nondestructive assay, the container would be moved to the mixing station. Then, measured quantities of water would be blended into the residue containers. The material would be mixed until the mixture thickens and appears homogeneous. Because of the potential for heat generation, provisions for actively cooling the container during and after mixing might required for certain residue IDCs. During mixing, there would be a potential for some vapor generation produced by the chemical reaction of the reagents. Therefore, provisions would be incorporated as necessary for the collection and extraction of these vapors in both the mixing station and curing station. The container would be moved from the mixing station into a set of curing gloveboxes and set aside for a 24-hour curing period. After curing has been completed, the cans would be bagged out of the glovebox.

Assayed containers of stabilized residue that meet the WIPP waste acceptance criteria would be transferred for final drum packaging. Two containers would be loaded into a pipe component already staged inside of a 208-L (55-gal) drum.

C.6 Detailed Process Descriptions for Processing Technologies with Plutonium Separation

There are several categories of residues (identified by the Item Description Code) selected for offsite shipment from Rocky Flats and processing elsewhere that presently have Resource Conservation and Recovery Act hazardous waste numbers associated with them. The residues are in the process of being recharacterized and having those hazardous waste numbers verified or removed. If the hazardous waste numbers are validated, any site receiving and processing the residues must comply with the Resource Conservation and Recovery Act hazardous waste regulations which the site's State (South Carolina, New Mexico, or Colorado) requires for the storage, treatment, and/or disposal of hazardous waste.

C.6.1 Purex Process with Plutonium Metal or Oxide Recovery at the Savannah River Site with Preprocessing at Rocky Flats

Purex stabilization processing of residues has been proposed at the Savannah River Site. This processing technology would require residue preprocessing at Rocky Flats.

The Purex processing of sand, slag, and crucible, and plutonium fluoride residues, and scrub alloy at the Savannah River Site is considered to be a proven technology, as is any preprocessing, packaging, and transportation which must occur to allow shipping of the materials. The capability for preprocessing and packaging at Rocky Flats is being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS.

After Rocky Flats preprocessing, the packaged residues would be shipped to the Savannah River Site and processed. Sufficient numbers of 6M shipping containers are available to ship the currently-stored scrub alloy. The Type B shipping containers required for shipping of powdered materials have been recently certified; these containers have been ordered by DOE, with expected delivery in September 1998. Safe secure trailers are available as required. The Purex process is considered to be a proven technology and an on-going operation, and the processing "canyon" will be available for scheduled windows of processing consistent with its other on-going missions. The technical and programmatic risks associated with residue shipping and processing at the Purex facility are considered minimal, with the exception of Fluoride "Heels," where this previously-extracted material may not be compatible with canyon operations because of their difficult dissolution characteristics.

❒ Preprocessing at Rocky Flats

Preprocessing options include various technologies depending on the residue type: ash fusion for incinerator ash residues; packaging of ash; grinding and packaging of sand, slag, and crucible; and repackaging of plutonium fluoride residues and scrub alloy. The preprocessing activities would be drum unloading/bag-in; feed preparation/bag-out; calcination and fusion with sodium peroxide (for incinerator ash); repackaging (for plutonium fluorides); nondestructive assay of cans for accountability purposes; loading cans into shipping containers; and moving them to interim storage with shipment to the Savannah River Site. Calcination of the incinerator ash would be required to convert reactive metals to unreactive oxides before mixing with sodium peroxide. For plutonium fluorides and scrub alloy, special precautions would need to be taken to minimize operator exposure due to high radiation fields. All glovebox operations for ash

residues would be performed in Building 707, while all glovebox operations for plutonium fluoride residues and scrub alloy would be performed in Building 371. The packaging process for shipment to Savannah River Site is shown in **Figure C–19**.

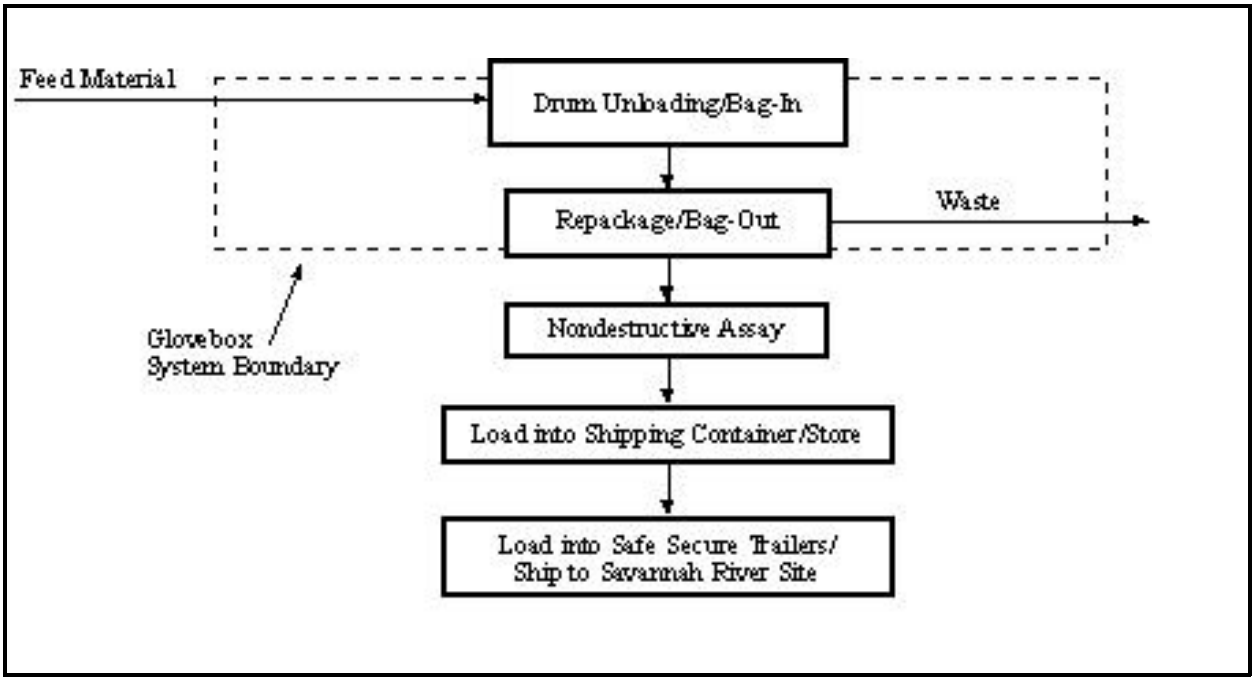


Figure C–19 Packaging Process at Rocky Flats for Shipment to Savannah River Site

Detailed Process Description

For the ash residues, drums would be manually transferred from storage into a contamination control enclosure. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drum would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred to the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox. If the integrity of the packaging has been compromised, the packaging would be overpacked with a new plastic bag before transfer to the glovebox.

- *Ash Fusion Preprocessing for Incinerator Ash Residues*—Incinerator ash would be introduced into the glovebox and the IDC verified. The individual packages would be opened and if necessary sieved to remove any tramp metal and other unwanted materials. Following the sieving, the incinerator ash would be crushed, as necessary, to produce a particle size which would facilitate calcination and subsequent fusion. The treated incinerator ash would again be sieved, if necessary, with a finer mesh screen and any large chunks returned to the crusher for reprocessing. The material would then be batched for calcining at nominally 2 kg (4.4 lb) bulk per batch. Combustible packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustible handling process. Other materials would be bagged out and treated appropriately. Each batch would be calcined at 900°C (1,650°F), which would oxidize carbon and organic to carbon dioxide and eliminate water, and increase the bulk density of the residues. Crushing may be required after calcination. After crushing, the batches would be available for fusion. The calcined batch, at approximately 1.5 kg (3.3 lb) bulk weight, would be mixed with about 400 g (14 oz) of crushed sodium peroxide reagent materials and placed in a 2-L (0.53-gal) mild steel can.

The mixture would be heated in a furnace to 450°C (840°F) for 2 hours and allowed to cool (4-hour cycle time). The dissolvable cans would be sealed and bagged out of the glovebox using dissolvable nylon bags. They would then be placed in larger "tall cans," also of mild steel.

- *Packaging Preprocessing for Sand, Slag, and Crucible Ash Residues*—After bag-in, the IDCs of the residue containers would be verified. As the containers are emptied, they would be transferred to a sorting and loading station. At the loading station, the residue would be removed from the containers and loaded into the crusher. The empty residue containers would be removed from the glovebox as solid waste. From the loading station, the residue would be processed through a crusher for size-reduction. The crushed material would then be screened through a mesh screen, packaged into a dissolvable mild steel can, crimp sealed, and weighed. Each can would contain approximately 2 kg (4.4 lb) bulk material based on estimated weight and volume limitations. If necessary, the contents would be sampled for plutonium assay. The cans would then be bagged out of the glovebox using special dissolvable nylon bags and sent to nondestructive assay. Coarse materials from screening would be re-crushed. The crusher and screening stations would provide local dust control.

- *Preprocessing for Plutonium Fluoride Residues*—Plutonium fluorides are currently stored in containers within an in-line vault in Building 371 and in Building 777. Because of the alpha-neutron reaction between plutonium alpha particles and fluorine nuclei, the unshielded radiation exposure of operators routinely handling this material may approach administrative limits. The principal radiation is neutrons, thus hydrogenous shielding (water walls) is necessary for operator protection. Cans of fluoride would be transferred from the storage area (an in-line vault) to a glovebox in Building 371 containing suitable neutron shielding (such as 5.1- to 10.2-cm [2- to 4-in] water walls). The materials would be transferred into a dissolvable mild steel tared container, crimp sealed, and weighed. The high assay fluorides may be sampled for plutonium analysis. The dissolvable container would be bagged out of the glovebox line. Special bags (nylon) that are readily dissolvable in the Savannah River Site dissolver would be used. The empty containers would be bagged out of the glovebox line, assayed with nondestructive assay, and disposed of as waste.

- *Preprocessing for Scrub Alloy* —Scrub alloy contains a high americium content, therefore, special precautions must be taken to minimize personnel radiation exposure. The alloy currently in stainless-steel containers needs to be repackaged. They would be removed from storage vaults (located in several buildings other than Building 371), transferred to Building 371, and bagged into a glovebox line. Outer packaging materials would be bagged out and managed appropriately. Once in the glovebox line, the scrub alloy would be removed from the stainless steel can and placed into a dissolvable mild-steel 1-L (0.26-gal) can that would be crimp-sealed, weighed, and bagged out of the line using dissolvable nylon bags. Two 1-L (0.26-gal) cans would be placed into a tall mild steel can. The original stainless steel cans and other packaging would be removed from the glovebox and disposed of as waste. The scrub alloy already packaged in dissolvable containers would be statistically sampled and inspected to verify integrity of the package. Some of the alloy is already stored in Type 6M containers ready to be shipped, and some is currently in dissolvable containers stored in building vaults ready to load into shipping containers. For materials already packaged, the dissolvable container is aluminum. Inspection would require opening the outer container or the shipping container and inspecting the condition of the inner container. If deterioration of the inner container is found, then the entire package would be bagged into the glovebox line and repackaged. Repackaging would use mild steel as the dissolvable container. Dissolvable containers in shipping containers which are not inspected would be transferred directly to interim storage or to Safe Secure Transport or other DOE-approved transport, as appropriate loading. Containers that need to be loaded into shipping containers but do not require nondestructive assay would be transferred

directly to shipping container loading. Packages ready for shipment would not be re-assayed using nondestructive assay.

After preprocessing of each residue and scrub alloy, nondestructive assay would be performed to confirm the amount of plutonium being shipped to Savannah River Site. After nondestructive assay, the packages would be loaded into Type 9975 (Type 6M for scrub alloy) shipping containers, and transferred to the shipping facility. There would be two cans (one can for scrub alloy) placed into each shipping container. The shipping containers would be cleaned and surveyed for contamination before transfer to interim storage within the process building or to the Building 707 shipping facility. The loaded Type 9975 (Type 6M for scrub alloy) shipping containers would be picked up at the process building and transferred to the shipping facility, where they would be loaded into a safe secure trailer or other DOE-approved transport, as appropriate and transported to the Savannah River Site. The distance from Rocky Flats to Savannah River is approximately 2,620 km (1,625 mi).

❒ **Purex Processing at the Savannah River Site**

The Purex process at Savannah River Site following the preprocessing at Rocky Flats is shown in **Figure C–20**. The preprocessed residues or scrub alloy would be dissolved in a Savannah River Site Canyon facility with plutonium being separated from the residue using solvent extraction technology. The plutonium would be converted to metal or oxide, prepackaged into cans, and transferred to either the FB-Line or 235-F vault until the Savannah River Actinide Packaging and Storage Facility vault is complete, where packaging would be completed (container to meet DOE-STD-3013-96 [DOE 1996c]), and stored until decisions are made on fissile material disposition. Any plutonium separated would be disposed of using an immobilization process. This process is currently in operation and no changes to the process are required to process residues and scrub alloy.

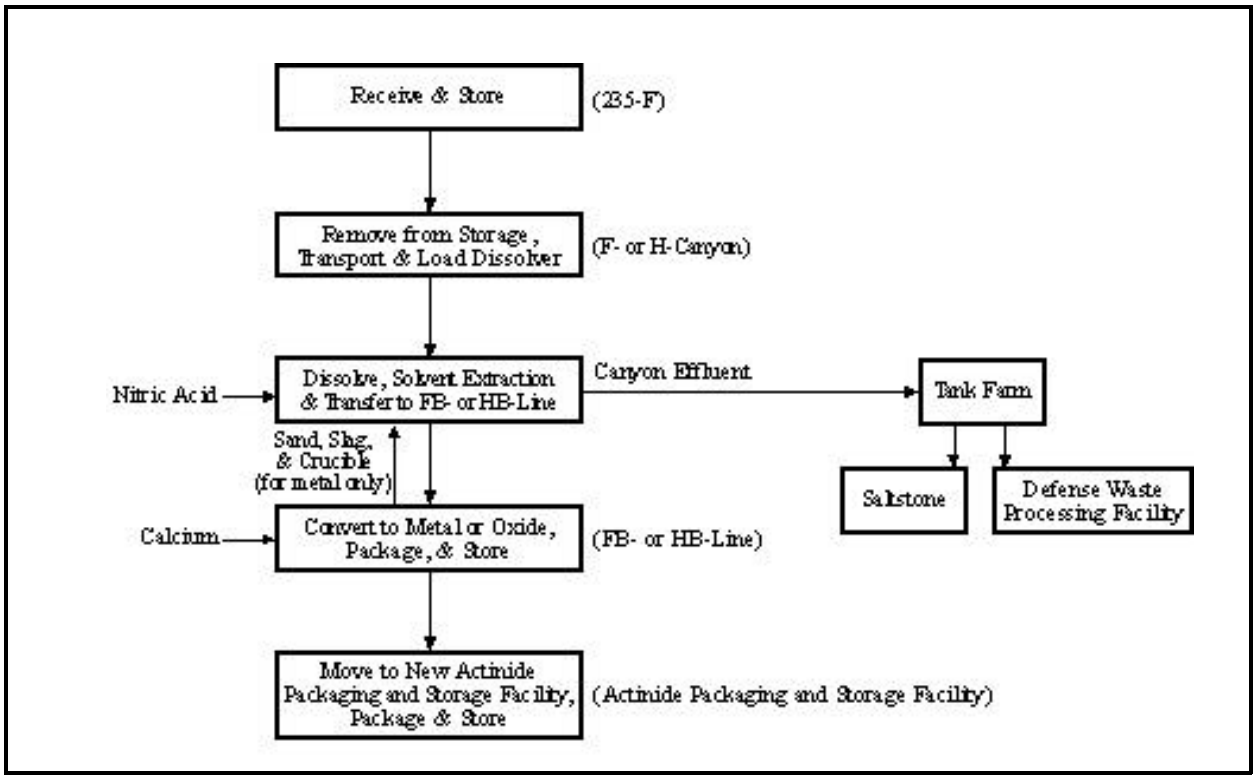


Figure C–20 Purex Process

Detailed Process Description

The shipping containers received from Rocky Flats would be unloaded, confirmatory measurements would be made, and the containers would be placed in a vault-like room in the 235-F facility. Shipping containers would be removed from storage and transported to the F- or H-Canyon crane maintenance area where the shipping containers would be opened and the cans loaded into a dissolver tube. The dissolver tube would then be loaded into a dissolver by remote control. Heated nitric acid in the tank would dissolve the residue or scrub alloy, resulting in a solution containing many constituents (dependent on material type). The solution would be purified by removing the impurities in an aqueous stream. The waste liquid would be transferred from the Savannah River F- or H-Canyon to the Savannah River high-level waste system. The plutonium product solution would be transferred to canyon hold tanks for later transfer to the finishing line.

The FB-Line process would include concentration of plutonium by cation exchange, precipitation of plutonium as a trifluoride, recovery of the trifluoride by filtration, drying of trifluoride in an oxygen atmosphere, and reduction with calcium metal to form plutonium metal buttons. The sand, slag, and crucible generated from button reduction will be dissolved in F-Canyon. The HB-Line process would include concentration of plutonium through anion exchange, precipitation of plutonium as plutonium oxalate, recovery of the oxalate by filtration, drying and calcining the oxalate, converting it to plutonium oxide. The metal buttons and oxide would be prepackaged into cans and placed in an F area vault for temporary storage. The cans would then be removed from the F area vault, placed into shipping containers, and transported to either the FB-Line or 235-F vault until the Actinide Packaging and Storage Facility is complete. At the vault the cans would be removed from the shipping containers, packaged into an outer 3013 container, and placed into the vault for long-term storage pending disposition in accordance with

decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement.* Any plutonium separated would be disposed of using an immobilization process.

C.6.2 Mediated Electrochemical Oxidation

The mediated electrochemical oxidation process is a relatively new dissolution process which has been incorporated into a standard aqueous separation process for the stabilization of plutonium-containing residues. The mediated electrochemical oxidation/aqueous process would be used to remove the majority of the plutonium from the residue matrix material, creating a concentrated plutonium oxide stream and leaving the residual material suitable for disposal at WIPP. It is a dissolution process to separate plutonium from a residue using a highly oxidizing metal cation generated in an acid solution using an electrochemical cell. These metal cations would migrate from the anode to the residue surface, and oxidize any reactive substance present on exposed surfaces. The mediated electrochemical oxidation process would be used to dissolve less reactive plutonium materials from residues, along with some of the residue matrix. Depending on the substrate material, the mediated electrochemical oxidation process would oxidize some materials into carbon dioxide and water. Once dissolved, the plutonium species would be removed from the other dissolved solids by precipitation as a plutonium oxalate solid. All separated and residual solids would be treated for storage and shipment, and the liquids solidified as transuranic or low-level waste.

Mediated electrochemical oxidation has been proposed at Rocky Flats (for combustible, filter media, glass, graphite, and inorganic residues) and at Savannah River with preprocessing at Rocky Flats (for incinerator ash and graphite and firebrick fines, and graphite and inorganic residues). Though similar, enough details differ to warrant two discussions.

C.6.2.1 Mediated Electrochemical Oxidation at Rocky Flats

The mediated electrochemical oxidation process would principally be conducted inside gloveboxes located in Room 3701 of Building 371. The mediated electrochemical oxidation process for residues is shown in **Figure C–21**.

The mediated electrochemical oxidation process at Rocky Flats, consisting of dissolving the plutonium and oxidizing "combustible" constituents contained in various residues, filtering the solution, and precipitating and calcining a plutonium oxalate, is considered to be a well-demonstrated technology with radioactive materials, although not yet used in production operations in DOE facilities. The process would be required to be installed in areas of Building 371 adjacent to the neutralize-dry process to take advantage of the liquid treatment facilities. The requirements for using this area for other residue activities (e.g., neutralize dry, cementation) would impact the installation, testing, and operational schedule of new process equipment. Therefore,

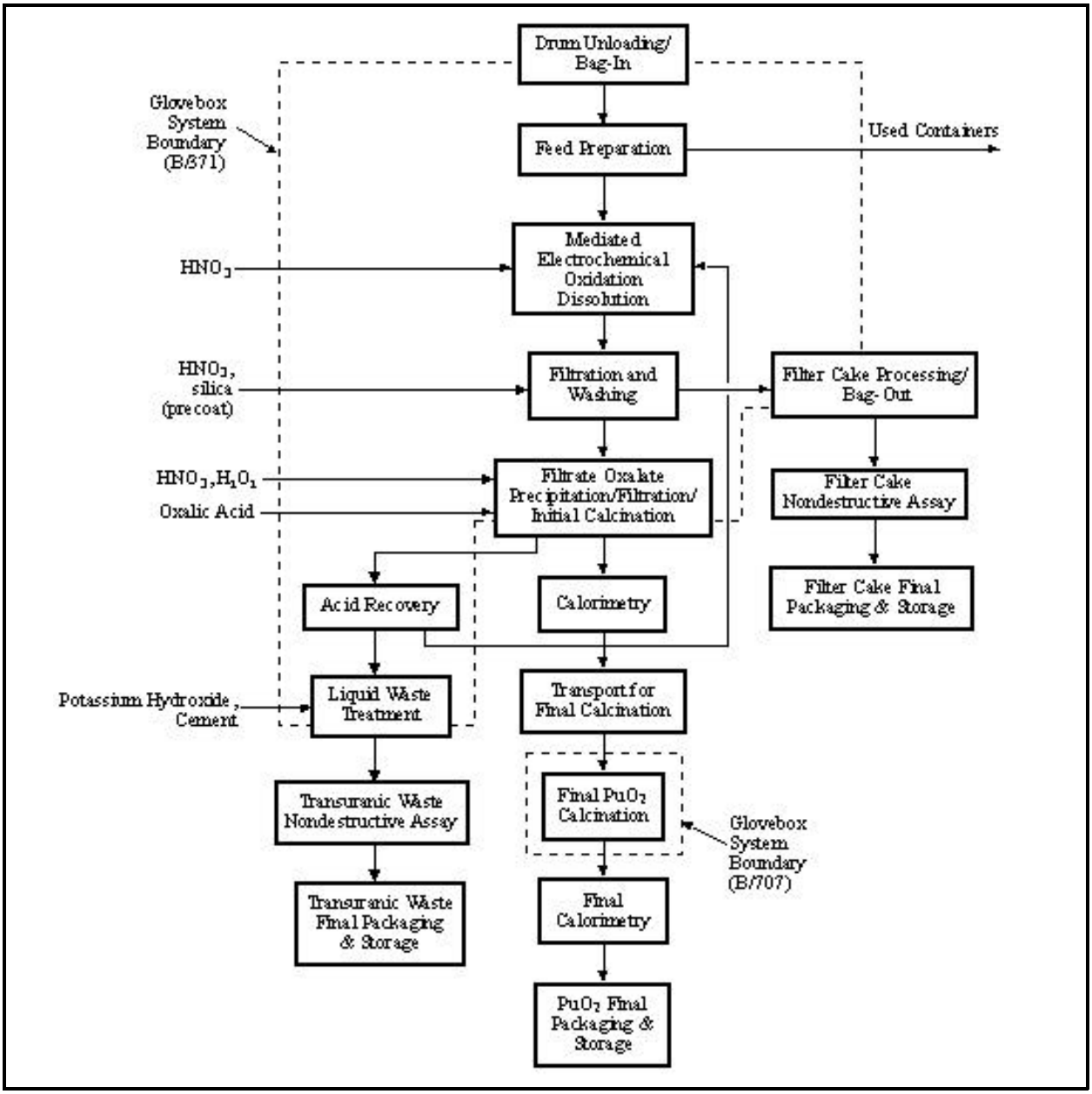


Figure C–21 Mediated Electrochemical Oxidation Process at Rocky Flats

operations of the mediated electrochemical oxidation process may not be able to start until a minimum of 4 years after issuance of the Record of Decision.

❒ Detailed Process Description

Drums would be manually transferred into a contamination control enclosure and unpacked. This would contain any contamination which could result from an individual package containment damaged by radiolysis or other physical damage to the package during storage. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox.

After bag-in, the IDCs of the residue containers would be verified and the original residue containers would be transferred to a residue sorting and loading station which would provide local dust control and a sorting

station to separate all oversized residue and tramp material. The residues would either be shredded and batched (combustibles) or just batched (filter media, glass, and inorganic residues) into a dissolver feed container.

Graphite residues would be crushed and sieved over a 0.32-cm (1/8-in) sieve, with oversized pieces returned to the crusher, and the material passing the sieve would be batched into a dissolver feed container. Each dissolver feed container may be batched to hold either 5 kg (11 lb) of bulk residue or 200 g (7 oz) or less of plutonium. A verification step would take place to ensure that each transfer container would contain less than 200 g (7 oz) of plutonium using a gram estimator. The dissolver feed container would be transferred to the dissolver glovebox as required.

The mediated electrochemical oxidation dissolution step would consist of a 40-L (10.6-gal) mediated electrochemical oxidation dissolver, an electrolysis cell where divalent silver ions would be generated, a catholyte regeneration system, a condenser for off-gas treatment, and piping and tankage to support the equipment. The process would be operated on a batch basis.

First, the dissolver tank/anolyte compartment would be filled with concentrated nitric acid and monovalent silver ions. The electrolysis cell would be started and solution will be recirculated between the cell and the tank. The pre-batched residue would be fed into the solution, which would be agitated to maintain the solution in contact with the solid particles. The solution temperature would be maintained at between 80 and 90°C (176 and 194°F). Each dissolution batch would take two hours of active dissolution time, with another 2 hours of tank draining/filtering time and recharging and feed time. Most carbonaceous materials in the residue feed would be oxidized to carbon dioxide and water.

A filtration and washing step would filter the dissolver slurry through two vacuum drum filters with 30.5-cm (12-in) diameter drums covered with a precoat of porous silica material. The precoat would be sucked onto the rotating, fabric-covered drum in an initial step to create a filter cake, and then the dissolver slurry would be fed into the pan in which the drum would be rotating. As vacuum is applied, some of the liquid from the slurry would be sucked through the precoat while the slurry solids adhere to the precoat surface. The solids remaining on the cylindrical precoat surface would cause the liquid flow through the precoat to diminish and nearly stop in a given area. The rotation of the drum would bring these blinded areas out of the pan, where they would be spray-washed with nitric acid to displace some of the entrained solution. Before the blinded/washed area would rotate back into contact with the slurry in the pan, the outer layer of solids and precoat would be cut off to expose fresh precoat surface for filtration. The mixture of the residual solids and precoat cut from the filter, and liquids which would be entrained with it, would be collected in pans as the waste from the dissolution process. Liquids collected in a vacuum receiving tank would be transferred as feed for the oxalate precipitation process.

The pans of filter cake solids (residual solids and precoat) would be placed in an oven and heated to 150°C (300°F) for approximately 1 hour, and then placed in a 20-L (5.3-gal) can. When a can is filled, it would be taped and bagged out of the glovebox. After the solids would be dried, packaged, and removed from the glovebox line, nondestructive assay would be performed on the cans. Containers of assayed solids that meet the WIPP/Waste Acceptance Criteria fissile material limits would be transported as necessary for final drum packaging. Approximately two containers would be loaded into a pipe component staged inside a 208-L (55-gal) drum. The sealed drums would be placed into interim site storage awaiting shipment to WIPP.

The plutonium-rich solution recovered from filtration would be transferred to the precipitation feed tanks, where it would be prepared for precipitation. The batched material would be placed in glass agitated

precipitator columns, and oxalic acid would be added. After a digestion period to allow for the formation and growth of plutonium oxalate crystals, the slurry would be drained into stainless steel filter boats with a sintered metal filter. The liquids would be sucked through the filter, leaving the solid plutonium oxalate material within the filter boat. This filter boat would be placed in a calciner and heated to approximately 400°C (750°F) for an hour to decompose the plutonium oxalate to plutonium oxide and carbon dioxide. The plutonium oxide would then be consolidated into slip-lid cans, weighed, and bagged out of the glovebox. The package would be loaded into a convenience can as necessary prior to being nondestructively assayed and transported to Building 707 for final calcination.

The plutonium oxide package would be assayed for plutonium content based on its rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be ready for storage. This activity is required to maintain accountability within the mediated electrochemical oxidation material balance area. The cans containing the plutonium oxide would be placed in appropriate outer containers and transferred to the Building 371 loading dock. The containers would then be transported to the Building 707 loading dock by intra-site truck transportation, and moved to appropriate vault storage pending final calcination.

The plutonium oxide cans would be transferred from the Building 707 storage vault to Module J and bagged into the plutonium stabilization and packaging system. The plutonium oxide would be removed from the cans, placed in furnaces, and calcined at 1,000°C (1,800°F) for 4 hours. The material, now suitable for long-term storage or transportation, would be weighed, characterized, and placed in a 3013 inner container. This container would then be removed from the glovebox via the bagless transfer process and sent to calorimetry. The plutonium oxide package would be assayed for plutonium content based on its rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be placed in vault storage pending disposition in accordance with decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement.* Any plutonium separated would be disposed of using an immobilization process.

The spent solution would be transferred to a batch evaporator where approximately 82 percent of the water and acid in the solution would be evaporated and condensed to be recycled through the dissolution and filtration wash steps as recycled acid. The unevaporated acid solution, containing the remaining dissolved solids, would be transferred to liquid waste treatment. The use of this acid recovery step would reduce the amount of low-level waste generated by about 80 percent. The waste acid stream from the recycle evaporator would be combined with potassium hydroxide in a cooled neutralization tank to produce a solution pH between 6.0 and 9.0. The neutralized solution and cement would be mixed together in a 208-L (55-gal) drum at a water to cement ratio of 0.2 to 0.4, and a waste loading of 15 percent to 25 percent. After the solidified transuranic waste solids are cured and removed from the glovebox line, nondestructive assay would be performed on the drums. Containers of assayed solids that meet the WIPP/Waste Acceptance Criteria fissile material limits would be transported as necessary for final drum packaging and the sealed drums would be placed into interim site storage awaiting shipment to WIPP.

C.6.2.2 Mediated Electrochemical Oxidation at Savannah River Site with Preprocessing at Rocky Flats

The stabilization of residues with the mediated electrochemical oxidation process at the Savannah River Site would require preprocessing at Rocky Flats, which would include crushing the residues as necessary, calcining (for incinerator ash and graphite and fire brick fines), and repackaging the residue materials in preparation for shipment. The cans would be bagged out of the glovebox using dissolvable nylon bags and nondestructively assayed for accountability purposes, packaged in the final transport/storage container, and stored in interim

storage or sent directly to a safe secure trailer or other DOE-approved transport, as appropriate for shipment to the Savannah River Site.

The calcining and packaging process for incinerator ash and graphite and firebrick fines would be conducted inside a glovebox located in Module E of Building 707, while Mediated Electrochemical Oxidation glovebox operations would be performed in Building 371. Calcination of the incinerator ash and graphite and firebrick fines would be required in order to high-fire the material to prevent off-gassing during shipment. The packaging process for shipment to Savannah River Site is shown in **Figure C–22**. The mediated electrochemical oxidation process at Savannah River is considered to be a proven technology. The process would be required to be installed in the New Special Recovery facility. Operations of the mediated electrochemical oxidation process may not be able to start until 2 years after issuance of the Record of Decision.

❒ **Preprocessing at Rocky Flats**

Detailed Process Description

Drums would be manually transferred into a contamination control enclosure and unpacked. This would contain any contamination which could result from any individual package containment failure or damage by radiolysis or physical damage to the package during storage. The drum would be opened and the integrity of the packaging would be checked.

If the packaging has not been compromised, the containers would be transferred to the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the residue preparation glovebox. If the integrity of the packaging has been compromised, the packaging would be overpacked with a new plastic bag prior to transfer to the glovebox. All individual containers would be bagged into the preparation glovebox.

The residue material would be introduced into the glovebox, the IDC verified, and each package would be opened and sorted/sieved to remove any tramp metal and other unwanted materials. Following the sorting/sieving, the residue materials would be crushed, if necessary. For organic and graphite residues, this would provide small enough material to fit inside a 1-L (0.26-gal) dissolvable can.

The materials would then be batched into the dissolvable cans so that the cans would contain an average bulk amount of 2 kg (4.4 lb). For the materials requiring calcining, the residues would again be sieved, if necessary, with a finer mesh screen and any large chunks returned to the crusher for reprocessing. The materials would then be batched for calcining so that, after calcination, the shipping cans would contain an average bulk amount of 2 kg (4.4 lb). The repackaging of all residues is bulk weight dependent, not plutonium weight dependent.

The cans would be bagged out of the glovebox using dissolvable nylon bags. Combustible packaging materials from the individual containers would be bagged out of the glovebox and sent to a combustible handling process. Other unwanted materials would be bagged out of the glovebox and managed appropriately.

For the incinerator ash and graphite and firebrick fines, each batch would be calcined at 900°C (1,650°F), which would oxidize carbon and organic to carbon dioxide and eliminate water, and increase the bulk density of the residues. Crushing may be required after calcination. After crushing, the batches would be available for final packaging.

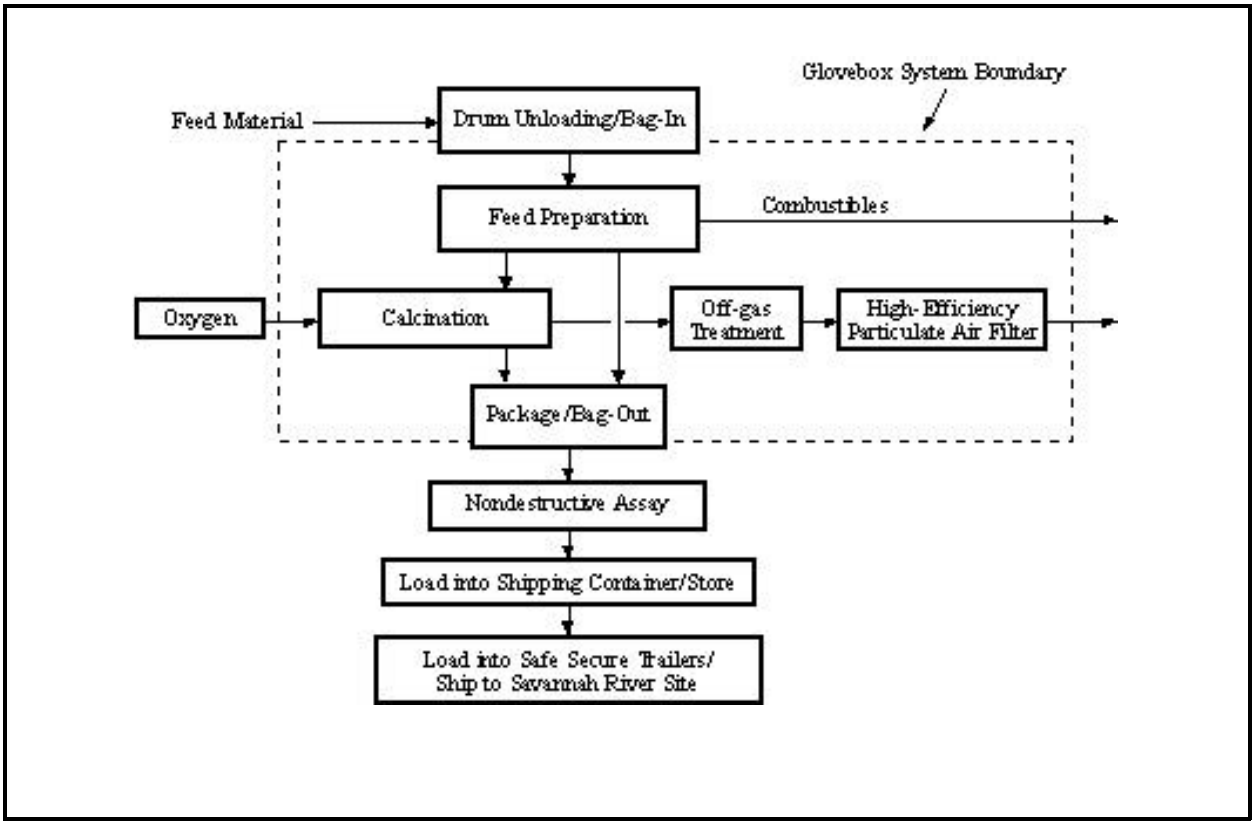


Figure C–22 Packaging Process at Rocky Flats for Shipment to Savannah River Site

Nondestructive assay would be performed using a segmented gamma scanner to confirm the amount of plutonium being shipped to the Savannah River Site. After nondestructive assay, the packages would be loaded into Type 9975 shipping containers and transferred to the shipping facility. There would be two cans placed into each shipping container. The shipping containers would be cleaned and surveyed for contamination before transfer to interim storage within the Building 371 or to the shipping facility. The loaded Type 9975 containers would be picked up at the process building and transferred to the shipping facility, where they would be loaded into a safe secure trailer or other DOE-approved transport, asappropriate and transported to the Savannah River Site. The distance from Rocky Flats to the Savannah River is approximately 2,620 km (1,625 mi).

❒ Mediated Electrochemical Oxidation at the Savannah River Site

The mediated electrochemical oxidation process at the Savannah River Site following preprocessing at Rocky Flats is shown in **Figure C–23**. The plutonium within the preprocessed residues would be leached and/or dissolved in the New Special Recovery or HB-Line facility using two newly installed dissolvers that use the silver II ion to dissolve the normally intractable plutonium in the residue. Once the plutonium is in solution, the residue would be separated/filtered out and discarded as transuranic waste.

The plutonium would be converted to metal or oxide which would be prepackaged into cans and placed in the FB- or HB-Line. It would be transferred to the Savannah River Actinide Packaging and Storage Facility or another Savannah River vault where packaging would be completed (outer container to meet DOE-STD-3013-96 [DOE 1996c]) and it would be stored until decisions are made on fissile material disposition. The Plutonium Storage Facility and New Special Recovery facility are not currently in operation and would require two silver dissolvers to be installed and the facilities started up; the HB-Line

is operating and would require modification to existing, or installation of new silver dissolvers. All other facilities are currently in operation and no changes to the process would be required.

Detailed Process Description

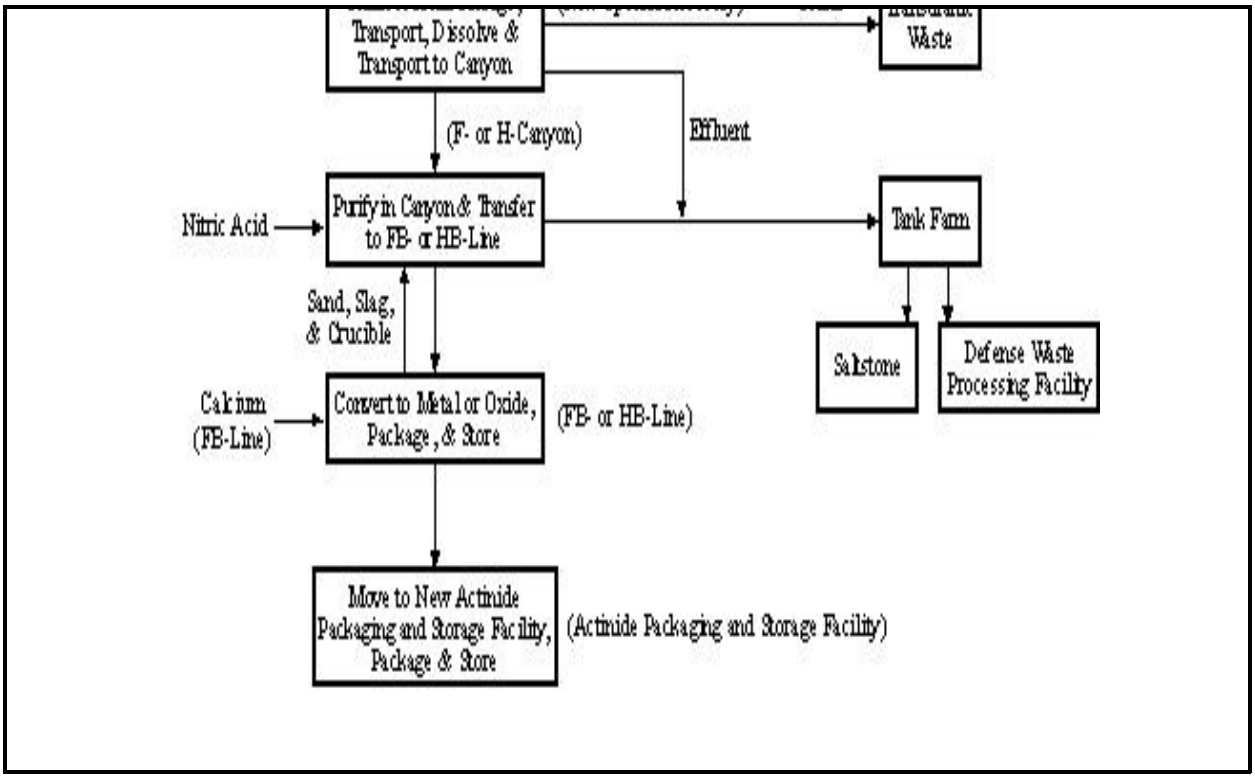


Figure C–23 Mediated Electrochemical Oxidation Process at Savannah River

The shipping containers received from Rocky Flats would be unloaded, confirmatory measurements made, and the containers placed in the Plutonium Storage Facility or other Savannah River Site vault (such as 235-F). One batch of shipping containers would be removed from storage and moved via a conveyor to New Special Recovery or transferred to the HB-Line where each shipping container would be opened up and the two cans removed. The cans would be opened and the contents processed through a leach/dissolve (or wash/filter/dissolve) and filter cycle in a silver dissolver. Any nondissolved material would be discarded as transuranic waste. The silver would be continually reused and the filtered plutonium solution would be transferred to F- or H-Canyon.

Waste liquid containing impurities and residual plutonium would be transferred from the Savannah River Site canyon to the Savannah River Site high-level waste system. The residual plutonium would be vitrified as borosilicate glass in the Savannah River Site Defense Waste Processing Facility. Savannah River Site high-level waste glass is scheduled for disposal in a deep monitored geological repository beginning in 2015. Decontaminated aqueous solutions containing the residue and associated spent processing reagents (the bulk of the secondary waste) would be transferred to the Savannah River Site Z-Area Saltstone Treatment and Disposal Facility. The resultant nonhazardous stabilized waste form would be disposed of in engineered vaults at the Savannah River Site low-level radioactive industrial landfill.

Within the canyon facilities, nitric acid would be added to the primary plutonium solution to dissolve the remaining solids (for incinerator ash and fines) and purified (for all proposed residues) by removing the

impurities in an aqueous stream. The plutonium product solution would be transferred to F- or H-Canyon hold tanks for later transfer to FB- or HB-Line.

The FB-Line process would include concentration of plutonium by cation exchange, precipitation of plutonium as a trifluoride, recovery of the trifluoride by filtration, drying of trifluoride in an oxygen atmosphere, and reduction with calcium metal to form plutonium metal buttons. The sand, slag, and crucible generated from button reduction would be dissolved in F-Canyon. The HB-Line process would include concentration of plutonium through anion exchange, precipitation of plutonium as plutonium oxalate, recovery of the oxalate by filtration, drying and calcining the oxalate, converting it to plutonium oxide. The metal buttons and oxide would be prepackaged into cans which would be placed in an F area vault for temporary storage. The cans would then be removed from the F area vault, placed into shipping containers, and transported to the Actinide Packaging and Storage Facility. At the Actinide Packaging and Storage Facility, the cans would be removed from the shipping containers, packaged into an outer 3013 container, and placed into the vault for long-term storage pending disposition in accordance with decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement.* Any plutonium separated would be disposed of using an immobilization process.

C.6.3 Salt Distillation

Salt distillation technology would require pyro-oxidation of the sodium/potassium chloride pyrochemical salts to convert reactive metals to oxides prior to salt distillation. This technology could be used on electrorefining salts and molten salt extraction salts. Salt distillation has been proposed at Rocky Flats and at Los Alamos National Laboratory with preprocessing at Rocky Flats. Though similar, enough details differ to warrant two discussions.

Salt distillation, consisting of the separation of the higher-vapor pressure alkali halide salts from the transuranic oxides, is considered to be a technology which has been well demonstrated on a pilot scale with actual residue materials, although optimization studies are ongoing and final designs of the production equipment would be required. Operations of the salt distillation process may not be able to start until 2 years after the issuance of the Record of Decision. The capability for salt distillation at Los Alamos National Laboratory is already installed and operational at Los Alamos National Laboratory on a pilot scale. Additional capabilities could be installed if necessary, however this capability would not be available for between 2-4 years after issuance of the Record of Decision.

An additional uncertainty involved in the salt distillation process is the disposition of the resultant transuranic oxide materials resulting from the processing of the molten salt extraction salts. These materials contain elevated concentrations of americium by comparison to other plutonium oxide materials, resulting in elevated gamma radiation levels which would have to be addressed in handling. Estimates of radiation levels from these oxides packaged in normal containers which meet DOE-STD-3013-96 indicate that the materials may not be suitable for storage at the new vault being constructed at the Savannah River Site, although special shielding approaches are being evaluated. In the event that shielding is an unacceptable alternative, these materials may have to be processed in another manner or stored separately prior to final disposition.

C.6.3.1 Salt Distillation at Rocky Flats

The vacuum distillation process would reduce the plutonium concentration below the safeguards termination limit for pyrochemical salts. The resulting products would be a lean transuranic salt waste to be shipped to WIPP and plutonium oxide to be stored at Rocky Flats. Vacuum distillation has not been shown to be effective

on calcium chloride (direct oxide reduction) salts. The entire distillation process would be conducted inside gloveboxes located in Module A and Module B of Building 707 or in Building 371.

The salt distillation process for pyrochemical salts is shown in **Figure C–24**. Electrorefining and molten salt extraction salts would be sorted and batched in preparation for pyro-oxidation. After pyro-oxidation, the salts would be vacuum distilled to separate the plutonium oxide from the salts. The packaged salts would be removed from the glovebox and nondestructively assayed for accountability purposes. The salts would be packaged in the final transport/storage container, and moved into interim storage, pending disposal at WIPP. The plutonium oxide would be transferred to the bagless transfer system for final calcination, removed from the glovebox line, nondestructively assayed for accountability purposes, and then transferred to plutonium storage.

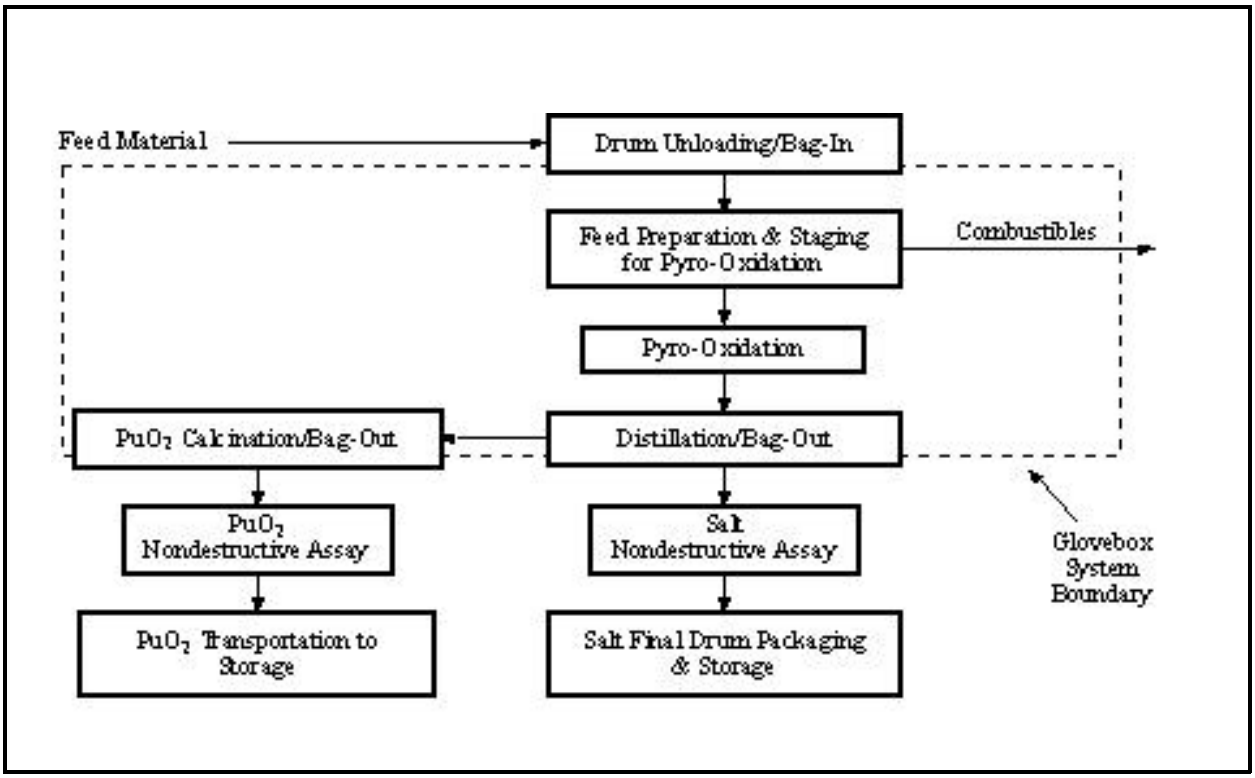


Figure C–24 Salt Distillation Process at Rocky Flats

❒ Detailed Process Description

Drums would be manually transferred into a contamination control enclosure and unpacked. This step is to contain any contamination which could result from an individual package containment damaged by radiolysis, or physical damage to the package during storage. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox. All of these individual containers would be bagged into the feed preparation glovebox.

The feed materials would be introduced into the glovebox, one stream at a time, and the IDC verified. The individual packages would be opened and loaded into a crucible in preparation for pyro-oxidation. Sodium carbonate or another oxidant would also be added to the crucible at this time. Combustible packaging materials from the individual packages would be bagged out of the glovebox and managed as transuranic waste. Other materials would be bagged out and managed appropriately.

Once the crucible is loaded with salt feed, it would be placed in a glovebox furnace and heated to approximately 800°C (1,470°F) with sodium carbonate or another oxidant as a reagent for 2 to 3 hours (8-hour cycle time), stirring continuously. The product would be a stabilized plutonium salt matrix. This process would convert reactive metals (such as sodium, calcium, or potassium) to oxides. When the furnace has cooled to below 100°C (212°F), the crucible would be removed from the furnace. During the heating, stirring, and cooling phases, argon would flow through the furnace. During the last part of the heating phase, argon would be replaced by a mixture of air and argon. Once the crucible has been removed from the furnace, it would be allowed to completely cool. The material would be placed into containers and transferred to the distillation glovebox via the chain conveyer system.

Each batch of pyro-oxidized salts would be placed into a vacuum distillation unit and distilled under vacuum for several hours (12-hour cycle time). The distillation process would remove the salts in gaseous form. The salt gases would be condensed to form a lean transuranic salt waste, leaving behind plutonium oxide. At this point, the salts are assumed to contain only parts per million amounts of plutonium. The salts would be batched into containers, bagged out of the glovebox, and packaged for nondestructive assay. The plutonium oxide would be placed into interim storage or directly transferred to the calcination glovebox for the required final plutonium oxide calcination, if necessary.

Nondestructive assay would be performed to ensure requirement limits are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data is obtained. Assayed product packages would be selected for final packaging to minimize the number of shipping containers required to be shipped to WIPP. Selected packages would be loaded into an inner container and sealed prior to placing the container into the final outer shipping container.

Plutonium oxide from the distillation process step would be removed from the cans and placed in furnaces, and calcined at 1,000°C (1,800°F) for 4 hours, if necessary to meet 3013 criteria. The material, now suitable for storage or transportation, would be weighed, characterized, and placed in a container. This container would then be removed from the glovebox using the bagless transfer process and sent to nondestructive assay. The plutonium oxide would be assayed for plutonium content based on its rate of thermal generation using calorimeters and Gamma-Ray Isotopic Spectrometer equipment. After assay, the containers would be ready for storage. Assayed product packages containing the plutonium oxide would be transported to appropriate plutonium storage areas pending disposition in accordance with decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement.* Any plutonium separated would be disposed of using an immobilization process.

C.6.3.2 Salt Distillation at Los Alamos National Laboratory with Preprocessing at Rocky Flats

❒ Preprocessing at Rocky Flats

A pyro-oxidation process, if necessary, would be conducted inside gloveboxes located in Module A of Building 707 or in Building 371 at Rocky Flats and the resulting products would be shipped to Los Alamos National Laboratory by safe secure trailer or other DOE-approved transport, as appropriate for final processing. The pyro-oxidation preprocessing process for pyrochemical salts and subsequent shipment to Los Alamos National Laboratory are shown in **Figure C–25**. The residue materials would be sorted and batched in preparation for pyro-oxidation. The salts would be pyro-oxidized to convert reactive metals to oxides. After pyro-oxidation, the oxidized plutonium salts would be packaged for storage and shipment. The packaged material would be removed from the glovebox, nondestructively assayed for accountability

purposes, and then packaged in the final transport/storage container and stored, if necessary, until it could be shipped to Los Alamos National Laboratory.

Detailed Preprocessing Description

Drums would be manually transferred into a contamination control enclosure and unpacked. This is to contain any contamination which could result from an individual package containment damaged by radiolysis, or physical damage to the package during storage. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox. All of these individual containers would be bagged into the feed preparation glovebox.

The salt feed would be introduced into the glovebox, one stream at a time, and the IDC verified. The individual packages would be opened and loaded into a crucible in preparation for pyro-oxidation. Sodium carbonate or another oxidant would also be added to the crucible at this time. Combustible packaging materials from the individual packages would be bagged out of the glovebox and managed as transuranic waste. Other materials would be bagged out and managed appropriately.

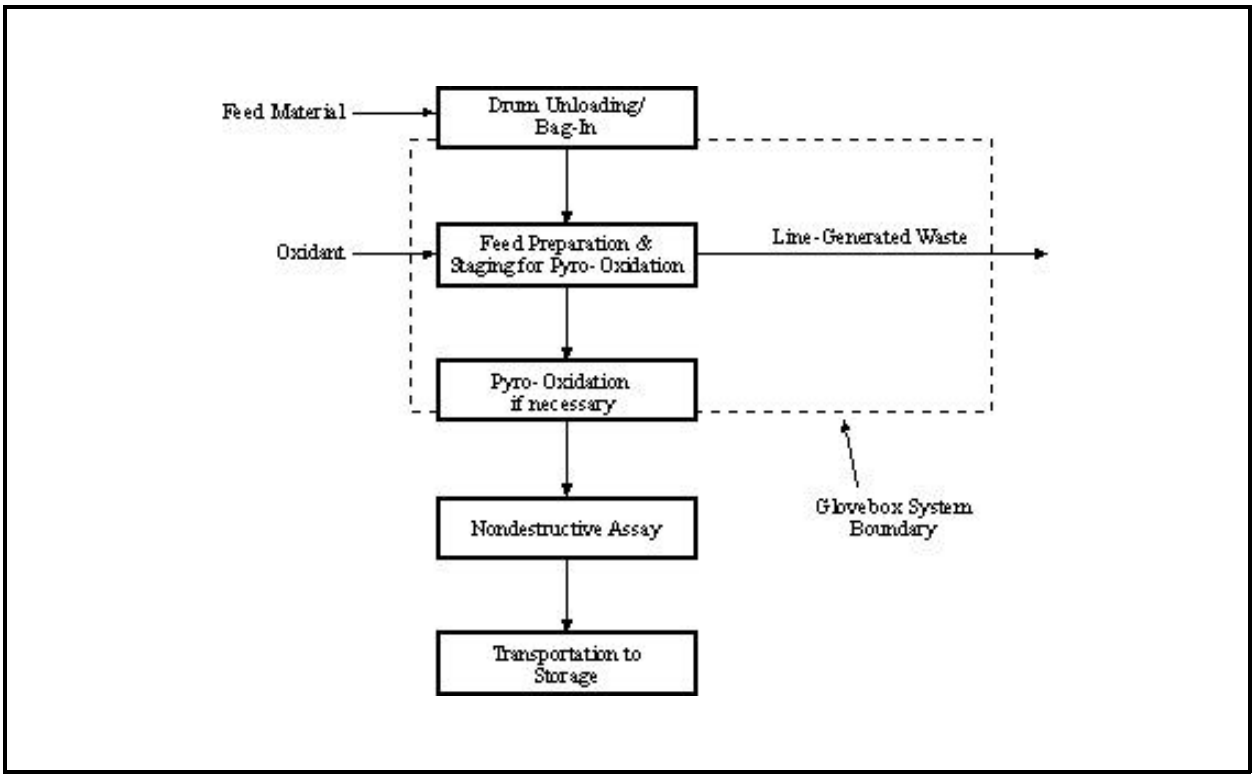


Figure C–25 Pyro-Oxidation Preprocessing Process

Once the crucible is loaded with salt feed, it would be placed in a glovebox furnace and heated to approximately 800°C (1,470°F) with sodium carbonate or another oxidant as a reagent for 2 to 3 hours (8-hour cycle time), stirring continuously. The product would be a stabilized plutonium salt matrix. This process would convert reactive metals, such as calcium, sodium, and potassium, to oxides. When the furnace has cooled to below 100°C (212°F), the crucible would be removed from the furnace. During the heating, stirring, and cooling phases, argon would flow through the furnace. During the last part of the heating phase, argon would be replaced by a mixture of air and argon.

Once the crucible is removed from the furnace, it would be allowed to completely cool before breakout. The salt matrix would then be removed from the crucible and the crucible discarded. The salt matrix would be placed into stainless steel containers in nominal 3.5-kg (7.7-lb) bulk (net) batches. The containers would be crimp sealed, weighed, and bagged out of the glovebox line. After bagout, two smaller cans would be placed in one tall can and sealed and nondestructive assay would be performed.

Calorimetry may be used for determining a heat signature for a shipping package. Packages would be loaded into 9975 Type shipping containers and transferred to interim vault storage or the shipping dock. There would be one can in each shipping container. The shipping containers would be cleaned and surveyed for contamination before transfer to either interim vault storage or the shipping dock. All transfers within the process building would be made by forklift. The loaded 9975 Type containers would be picked up at the process building or interim vault storage and transferred to the shipping facility, where they would be loaded into a safe secure trailer or other DOE-approved transport, as appropriate by forklift and transported to Los Alamos National Laboratory. The distance from Rocky Flats to Los Alamos is approximately 730 km (450 mi).

❒ **Salt Distillation at Los Alamos National Laboratory**

The salt distillation process at Los Alamos National Laboratory would separate sodium chloride/potassium chloride pyrochemical salt residues into a slightly contaminated (<100 parts per million [ppm] plutonium) salt fraction, suitable for disposal as transuranic waste, and a chloride-free, plutonium oxide powder suitable for long-term storage. The separation is based on the large difference in vapor pressure between alkali metal chlorides and actinide oxides at elevated temperatures. Calcium chloride has a much lower vapor pressure than the alkali metal chlorides and cannot be processed by present distillation equipment. The distillation of the plutonium salts would be carried out at Technical Area 55, Building PF-4, Room 420. The salt distillation process is shown in **Figure C–26**.

Detailed Process Description

The pretreated feed residues would be directly loaded into the Los Alamos National Laboratory salt distillation apparatus. The distillation unit has been designed to handle 3-kg (6.6-lb) salt batches. The distillation unit would be sealed and a vacuum applied. The furnaces on the evaporator side would be heated to 950°C (1,740°F) so that the salt would begin to evaporate and solidify on cool condenser surfaces. The condensing salt would raise the temperature of the condenser. Once all the salt has distilled from the evaporator side, the temperature of the condenser would begin to fall, signaling completion of the evaporation step. Typically, this occurs at 4 to 5 hours after heat is first applied. At this point, the unit would be backfilled with argon to atmospheric pressure and the condenser to 850°C (1,560°F) to melt the salt into a receiving mold. This would provide a convenient salt monolith for disposal and would typically require one hour. All power would be shut off and the unit allowed to cool to room temperature overnight.

If shorter times are required, active cooling could be used to speed the cycle up. It is unlikely a full cycle could be completed in an 8-hour shift; twelve hours is usually required for a complete load/unload cycle.

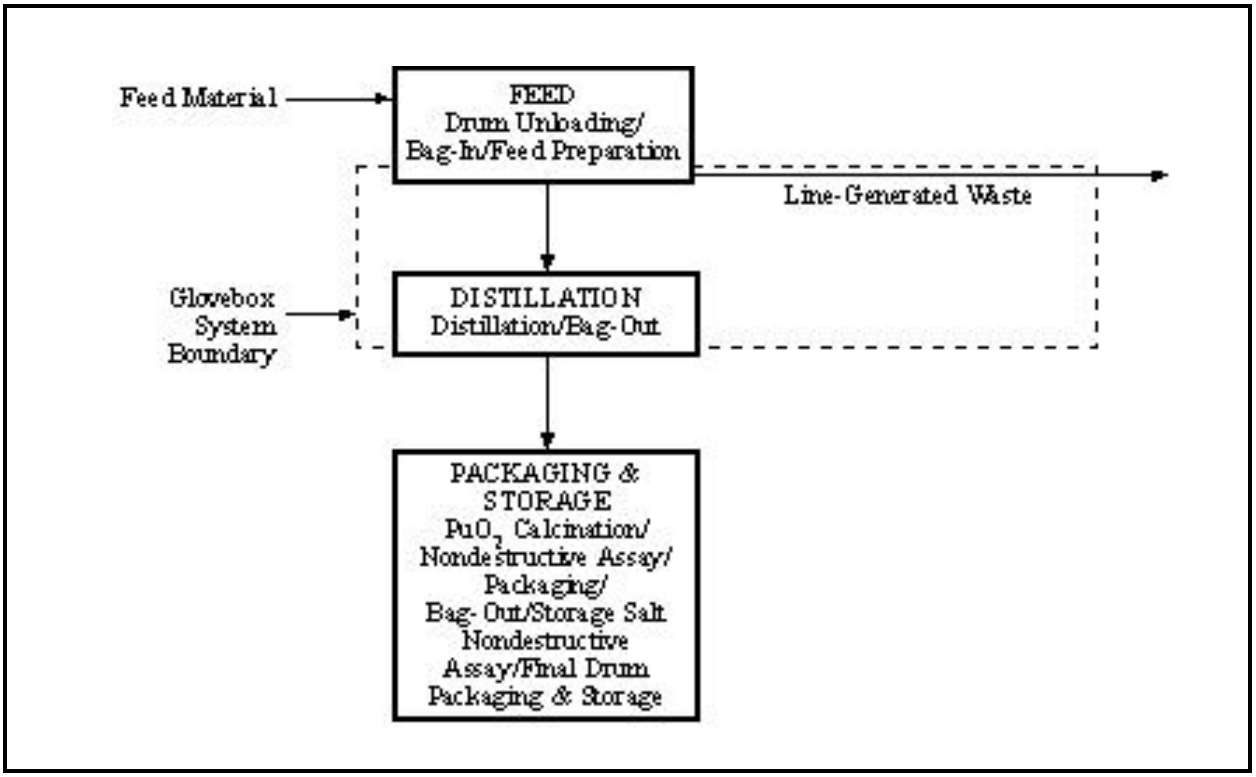


Figure C–26 Salt Distillation Process at Los Alamos

The waste salt would be packaged and removed from the glovebox line for nondestructive assay by neutron counting, and then loaded into a 208-L (55-gal) drum destined for WIPP. Because of the small amount of plutonium in the salt (<100 ppm), the drum could be filled to a volume capacity without exceeding the radionuclide or safeguards termination limit on waste for WIPP.

The oxide distillation heel would meet the criteria of DOE-STD-3013-96 (DOE 1996c) without further processing. However, several distillation runs would be required before the 4-kg (8.8-lb) batch size for packaging is accumulated. The oxide would begin to absorb atmospheric moisture once removed from the distillation unit. Unless rigorously dry conditions are maintained for in-line oxide storage, calcination would be required before final packaging. The oxide would be stored in TA-55 pending disposition in accordance with decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement.* Any plutonium separated would be disposed of using an immobilization process.

C.6.4 Water Leach with Plutonium Oxide Recovery

The water leach technology for pyrochemical salts would include the pyro-oxidation of calcium chloride pyrochemical salts to oxidize any reactive metals, followed by selective aqueous dissolution of the soluble portion of the salt. The insoluble plutonium-containing material would remain undissolved, and would be filtered and calcined to plutonium oxide for storage. The filtrate would be evaporated to dryness. Water leach has been proposed at Rocky Flats and at Los Alamos National Laboratory with preprocessing at Rocky Flats. Though the proposals are similar, enough details differ to warrant two discussions.

The water leach process at Rocky Flats is considered to be a proven technology. The process would be required to be installed in areas of Building 371 adjacent to the neutralize-dry process to take advantage of the liquid treatment facilities. The requirements for using this area for other residue activities (e.g., neutralize-dry, cementation) would impact the installation, testing, and operational schedule of new process equipment. Therefore, operations of the water leach process may not be able to start until a minimum of 4 years after issuance of the Record of Decision. The capability for water leach at Los Alamos National Laboratory is already installed and operational on a limited scale. Additional capabilities are available using a similar aqueous dissolution process. If any additional capabilities were necessary, they could be installed, however this capability would not be available for between 1–2 years after issuance of the Record of Decision.

| Although principally considered for direct oxide reduction salts, if the water leach process were to be used to process molten salt extraction salts (or those calcium chloride salts used for a molten salt extraction-type process) there is an additional uncertainty involving the disposal of the resulting transuranic oxide materials. These materials contain elevated concentrations of americium by comparison to other plutonium oxide materials, resulting in elevated gamma radiation levels which must be addressed in handling. Estimates of radiation levels from these oxides packaged in normal containers which meet DOE-STD-3013-96 indicate that the materials may not be suitable for storage at the new vault being constructed at the Savannah River Site, although special shielding approaches are being evaluated. In the event that shielding is an unacceptable alternative, these materials may have to be processed in another manner or stored separately prior to final disposition. Although these materials have been identified as being difficult to handle due to their higher than normal radiation levels, they are only one of a number of similar materials which must be accommodated for storage at the Savannah River Site.

C.6.4.1 Water Leach with Plutonium Oxide Recovery at Rocky Flats

| The entire water leach process would be conducted inside gloveboxes located in Rooms 3305 and 3701 of
| Building 371, except for the final calcination step, which would be done in Module J of Building 707. The
| resulting products would be a lean transuranic salt waste to be shipped to WIPP and plutonium oxide to be stored at Rocky Flats.

| The water leach process at Rocky Flats is shown in **Figure C–27**. The feed materials would be sorted and
| batched in preparation for pyro-oxidation. The salts would be pyro-oxidized to convert reactive metals to
| oxides. After pyro-oxidation, the salts would go through aqueous dissolution to dissolve the salts and soluble
| oxides. The solution would be filtered to separate the plutonium and americium oxides from the salt solution.
| The plutonium and americium oxides would be dried, nondestructively assayed for accountability purposes, calcined, and sent to storage pending DOE decisions on eventual disposition of the plutonium. The salt solution
| would be evaporated and the resulting salts would be dried, cast, packaged, and nondestructively assayed for
| accountability purposes. The salts would be packaged in the final transport/storage container, and moved into interim storage, pending disposal at WIPP.

| During the heating, stirring, and cooling phases, argon would flow through the furnace. During the last part
| of the heating phase, argon would be replaced by a mixture of air and argon. Once the crucible is removed
| from the furnace, it would be allowed to completely cool before breakout. The salt matrix would then be
| removed from the crucible and crushed to be more amenable to dissolution; the crucible would be discarded.
| The salt matrix would be packaged suitable for dissolution, bagged out, and transferred to Building 371 for the water dissolution step.

| After bag-in, the salt would be treated using the water dissolution process on a batch basis. Water dissolution
| would consist of placing the pyro-oxidized salts into a vessel approximately 15 L (4.0 -gal) in volume, adding

approximately two parts slightly acidified (1.7N HCl) water to one part total residue, and stirring for approximately 4 hours until the salts have dissolved. Approximately 90 percent of the water needed would be recycled from the filtrate evaporation step. Thus, a small quantity of 12.4N HCl and makeup water would be added to the recycle water in order to achieve the desired normality. After the salts have dissolved, the resulting solution would be treated in the filtration step.

❒ **Detailed Process Description**

Drums would be manually transferred from storage into a contamination control enclosure. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drum would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred to the glovebox. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox. If the integrity of the packaging has been compromised, the packaging would be overpacked with a new plastic bag prior to transfer to the glovebox. All of these individual containers would be bagged into the salt feed preparation glovebox. The salt materials would be introduced into the glovebox and the IDC verified. The individual packages would each be opened, batched to a 200 g (7 oz) maximum of plutonium, and then loaded into a magnesium oxide crucible in preparation for pyro-oxidation. An oxidant, such as sodium carbonate, would also be added to the crucible at this time. Combustible packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustible-handling process. Other materials would be bagged out and managed appropriately.

Once the crucible has been loaded with salt feed, it would be placed in a glovebox furnace and heated to approximately 800°C (1,470°F) with an oxidant such as sodium carbonate as a reagent for 2 to 3 hours, stirring continuously. The product would be a stabilized plutonium salt matrix. This process would convert reactive metals (such as calcium) to oxides. When the furnace has cooled to below 100°C (212°F), the crucible would be removed from the furnace.

After bag-in, the salt would be treated in the water dissolution process on a batch basis. Water dissolution consists of placing the pyro-oxidized salts into a vessel approximately 15 L in volume, adding approximately two parts slightly acidized water to one part total residue, and stirring for approximately 4 hours until the salts have dissolved. Approximately 90 percent of the water needed would be recycled

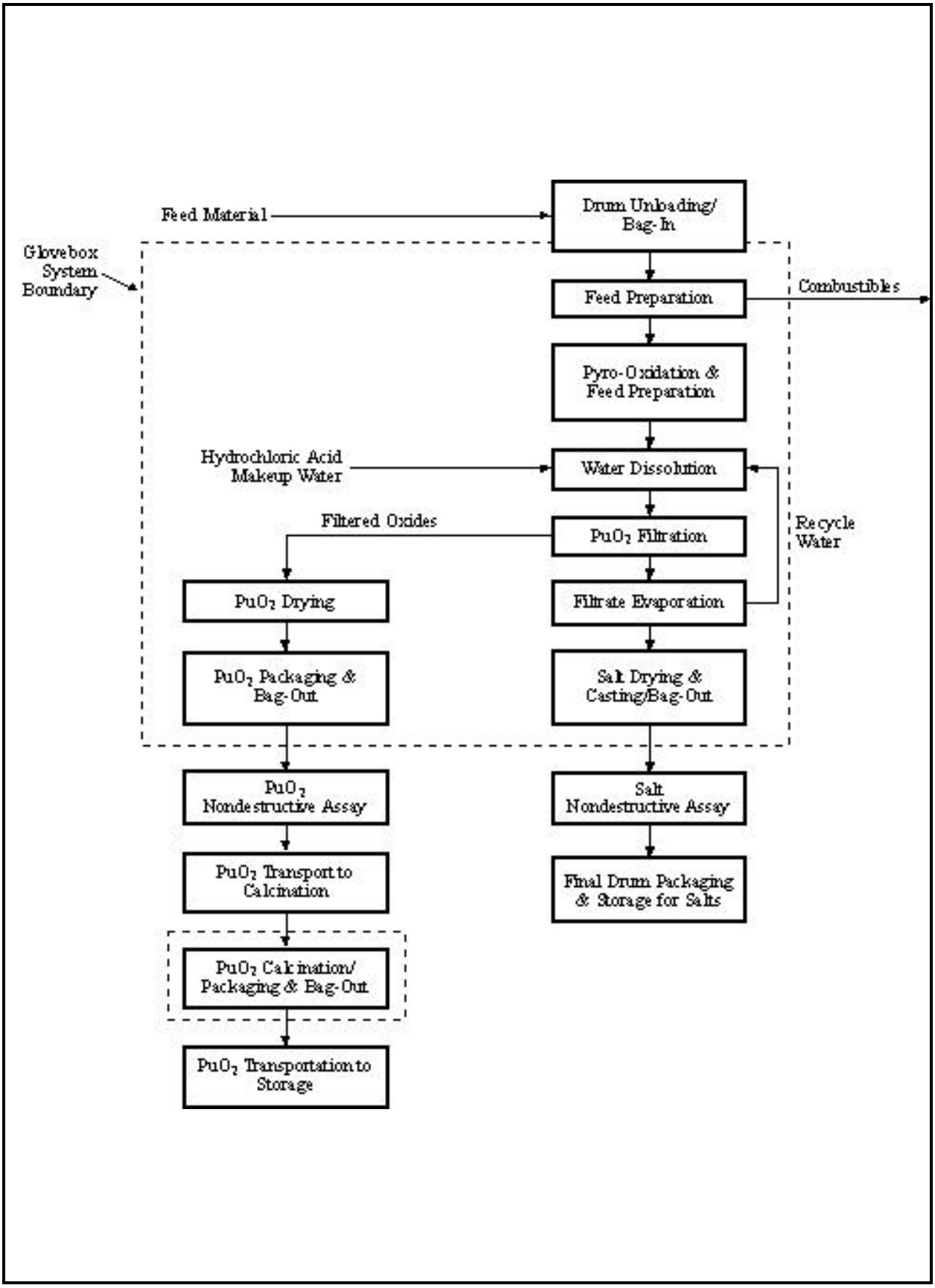


Figure C–27 Water Leach Process at Rocky Flats

from the filtrate evaporation step. Thus, a small quantity of high normality hydrochloric acid and makeup water would be added to the recycle water in order to achieve the desired normality. After the salts have dissolved, the resulting solution would be treated in the filtration step.

The salt solution from water dissolution would be decanted and the resultant wet solids vacuum filtered to remove the plutonium oxide and americium oxide solids from the salt solution. The filtered oxides would go to plutonium oxide drying and the lean salt solution would go to evaporation. The wet plutonium and americium oxides would contain about 20 percent water after filtration. They would be placed into a small furnace and dried for about 4 hours at about 400°C (750°F). The resultant material is assumed to be only plutonium and americium oxides.

After drying, the oxides would be batched to 1 kg (2.2 lb) of plutonium batches. The batches would be placed into slip-lid cans and bagged out into convenience cans for nondestructive assay. The plutonium and americium oxides would be assayed for plutonium content based on their rates of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be ready for final calcination. The oxides would be transferred by truck from Building 371 to Building 707 to be calcined in Module J.

Plutonium oxide from the nondestructive assay step would be removed from the cans, batched into 3-kg (6.6-lb) batches, placed into furnaces, and calcined at 1,000°C (1,800°F) for 4 hours. The material, now suitable for storage or transportation, would be weighed, characterized, and placed in a 3013 container. This container would then be bagged out and sent to storage. Product packages containing the calcined plutonium oxide would be transported to appropriate plutonium storage areas pending disposition in accordance with decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement.* Any plutonium separated would be disposed of using an immobilization process.

Two batches of filtered salt solution would be combined, placed into an evaporator unit and evaporated to a damp solid. The process would evaporate the water and cause the nonvolatile salts to remain in the product solids. The distillate water would be condensed and recycled back to the dissolution step, and the salts would be sent to the drying ovens. The batch of damp solids from evaporation would be placed into drying ovens and dried for about 4 hours at about 200°C (390°F) .

After drying, the salts would be placed into salt casting furnaces, heated to approximately 500°C (930°F) (melted) for about 1 hour, and cooled into solid form. The salts would be removed from the furnaces after cooling and packaged for bag-out. After bag-out, the salts would be sent to nondestructive assay.

Nondestructive assay would be performed to ensure requirement limits are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data is obtained. Assayed product packages would be selected for final packaging to minimize the number of shipping containers required to be shipped to WIPP. Selected packages would be loaded into an inner container and sealed prior to placing of the container into the final outer shipping container.

C.6.4.2 Water Leach with Plutonium Oxide Recovery at Los Alamos National Laboratory with Preprocessing at Rocky Flats

❒ Preprocessing at Rocky Flats

The stabilization of salts with the water leach process at Los Alamos National Laboratory would require preprocessing at Rocky Flats which would include pyro-oxidation, if necessary, to convert reactive metals to oxides. The pyro-oxidation process would be conducted inside gloveboxes located in Module A of Building 707. The feed materials would be sorted and batched in preparation for pyro-oxidation. The salts would be pyro-oxidized to convert reactive metals to oxides. After pyro-oxidation, the oxidized plutonium salts would be packaged for storage and shipment. The packaged material would be removed from the glovebox, nondestructively assayed for accountability purposes. It would then be packaged in the final transport/storage container and stored, if necessary, until it could be shipped by safe secure trailer or other DOE-approved transport, as appropriate to Los Alamos National Laboratory. The pyro-oxidation preprocessing process is shown in Figure C–25.

Detailed Process Description

Drums would be manually transferred into a contamination control enclosure and unpacked. This step is to contain any contamination which could result from any individual package containment which was damaged by radiolysis or physical damage. Any unnecessary packaging materials would be removed during this step to limit the amount of packaging introduced into the feed preparation glovebox. All of these individual containers would be bagged into the feed preparation glovebox.

The salt feed would be introduced into the glovebox, the IDC verified, and the individual packages would be opened and loaded into a magnesium oxide crucible in preparation for pyro-oxidation. An oxidant such as sodium carbonate would also be added to the crucible at this time. Combustible packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustibles handling process. Other materials would be bagged out and managed appropriately.

Once the crucible is loaded with salt feed, it would be placed in a glovebox furnace and heated to approximately 800°C (1,470°F) with an oxidant such as sodium carbonate as a reagent for 2 to 3 hours (8-hour cycle time), stirring continuously. The product would be a stabilized plutonium salt matrix. This process would convert reactive metals (such as, sodium, calcium, or potassium) to oxides. When the furnace has cooled to below 100°C (212°F), the crucible would be removed from the furnace. During the heating, stirring, and cooling phases, argon would flow through the furnace. During the last part of the heating phase, argon would be replaced by a mixture of air and argon. Once the crucible is removed from the furnace, it would be allowed to completely cool before breakout. The salt matrix would then be removed from the crucible and the crucible discarded. The salt matrix would be placed into stainless steel containers in nominal 3.5-kg (7.7-lb) bulk (net) batches. The salt matrix batches would be weighed and placed in steel containers. The containers would be crimp sealed, weighed, and bagged out of the glovebox line. After bag-out, two smaller cans would be placed in one tall can and sealed, and nondestructive assay would be performed. Calorimetry may be used for determining a heat signature for a shipping package.

Packages would be loaded into 9975 Type shipping containers with one tall can per shipping container, the shipping containers would be cleaned and surveyed for contamination, and then they would be transferred to interim vault storage or the shipping dock. The loaded 9975 Type containers would be picked up at the process building or interim vault storage and transferred to the shipping facility, where they would be loaded into a safe secure trailer or other DOE-approved transport, as appropriate. The pretreated salt shipments

would be transported to Los Alamos National Laboratory via safe secure trailer or other DOE-approved transport, as appropriate. The distance from Rocky Flats to Los Alamos National Laboratory is approximately 730 km (450 mi.).

❒ **Water Leach with Plutonium Oxide Recovery at Los Alamos National Laboratory**

Pyrochemical salts would be received from Rocky Flats for final processing. These salts would be dissolved in a water leaching process. The resulting products would be lean calcium chloride salt for shipment to WIPP, and plutonium oxide to be stored at Los Alamos National Laboratory in TA-55. The water leach of the plutonium salts would be carried out at Technical Area 55, Building PF-4, Room 420. The water leach process is shown schematically in **Figure C–28**. The process steps would include shipment by safe, secure trailer or otheer DOE-approved transport, as appropriate, unloading and receiving at Los Alamos National Laboratory, shipping container unloading and nondestructive assay, aqueous leaching and filtration, calcination of plutonium oxide, casting of calcium chloride salt, and bag-out. Nondestructive assay for plutonium oxide and salts would be performed, followed by final drum packaging and storage for salts, and transfer of the plutonium oxide to storage.

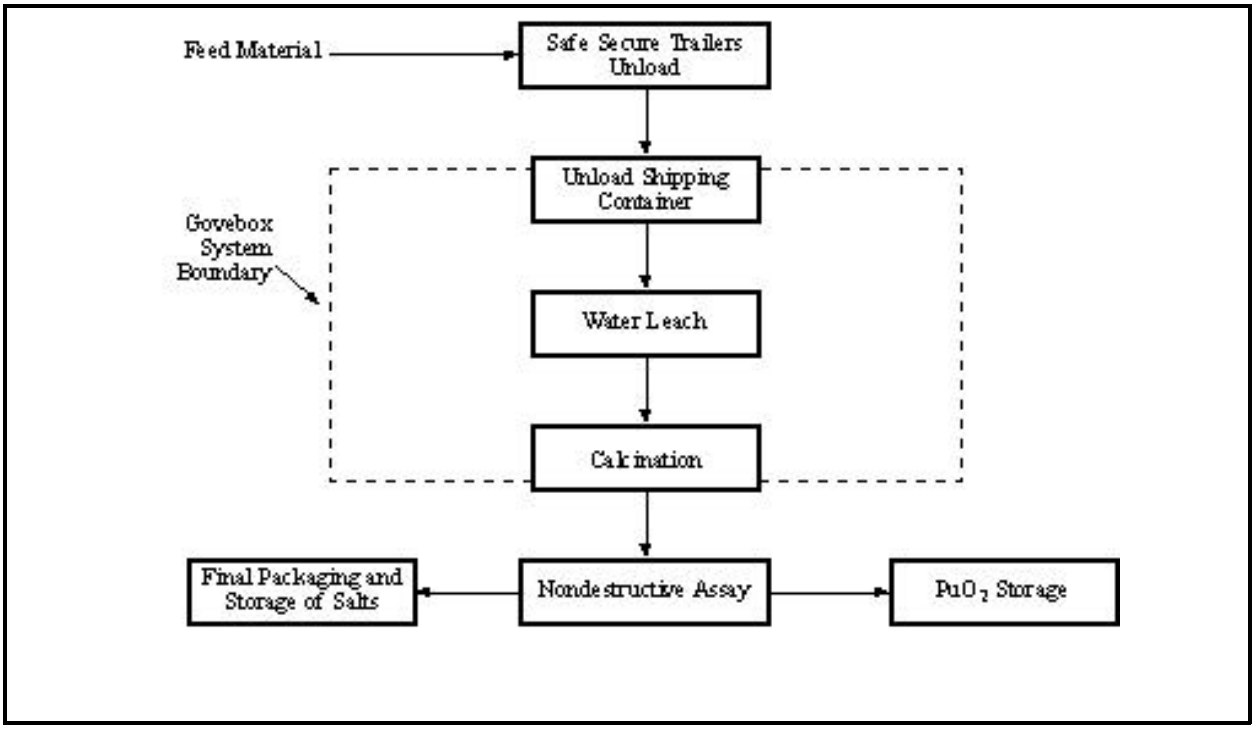


Figure C–28 Water Leach Process at Los Alamos

Detailed Process Description

The leach equipment would be sized to process a complete salt batch at one time. The salt batch would be placed in a leaching vessel sized to dissolve all the calcium chloride salt in the residue. During the leaching operation, the solution would become slightly alkaline from dissolution of excess sodium carbonate and the slight solubility of calcium oxide. Aqueous hydrochloric acid would be added to convert calcium oxide and sodium carbonate into the respective chlorides. This would be necessary to maintain the plutonium concentration in the filter cake above 50 percent. The pH of the solution would be monitored and would always be maintained above 7. The plutonium and americium oxides would remain insoluble. A 3-kg

(6.6-lb) batch of salt can be dissolved in 3 hours. During this time, an operator would monitor the operation for parameters such as temperature, mixing rate, leaching time, and dissolver condition. Once leaching has been completed, the slurry containing the plutonium and americium insolubles would be ready for filtration.

The slurry would be transferred to the filtration system, where the solids containing plutonium and americium oxides would be removed. The solids would be washed with water to remove salt contaminants. The clarified solution would be collected in a geometrically favorable tank and sampled for alkalinity and plutonium/americium concentration. The volume would be estimated at 6 L (1.6 -gal) per 3-kg (6.6-lb) batch. The solution would then be evaporated to dryness and the solid salt transferred to a furnace and heated to 850°C (1,560°F) for melt consolidation. The final plutonium concentration in the salt would be expected to be about 100 ppm. The insolubles collected on the filter would be removed and transferred to the calcination workstation. The wet cake from filtration would be placed in a crucible and calcined at 950°C (1,740°F) to remove water and other volatiles. The calcined product would contain less than 50 percent plutonium and would be stabilized. The stabilized product would be weighed and sampled for Pu and Am analysis, Loss on Ignition and transferred to a packaging workstation. The calcined product would be packaged in accordance with DOE-STD-3013-96 (DOE 1996c) and stored in TA-55 pending disposition in accordance with decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement*. Any plutonium separated would be disposed of using an immobilization process. Where batches contain small quantities of plutonium, multiple batches may be combined for storage after calcination.

C.6.5 Salt Scrub with Purex Processing of Newly Created Scrub Alloy

❒ Preprocessing at Rocky Flats

The salt scrub process for pyrochemical salts would reduce the plutonium level of the salts below the safeguards termination limit for pyrochemical salts and produces a high plutonium yield scrub alloy that would be shipped to Savannah River Site for further processing. The resulting low plutonium-bearing pyrochemical salts would be a lean transuranic waste to be shipped to WIPP. The salt scrub process can be used on electrorefining salts, molten salt extraction salts, and direct oxidation reduction salts. The salt scrub process would be conducted inside gloveboxes located in Modules A and B of Building 707.

The salt scrub process, consisting of the reduction and capture of plutonium and americium from chloride salts into a metal "button" in a pyrochemical process at Rocky Flats, and the subsequent shipment of the button to Savannah River for processing in the Purex process is considered to be a proven process for clean, recently-packaged salt residues. Technical uncertainties exist for this process as applied to less pure salts and/or salts which have absorbed moisture during storage. Development work would be required prior to or in parallel to the operations to address these uncertainties, with the result possibly being a population of salts not amenable to this technique. Since the scrub alloy process could be performed in the stationary furnaces that have been installed at Rocky Flats as part of the No Action Alternative, currently-installed capability exists to support the this process, although the scrub alloy processing would have to be coordinated with the current pyro-oxidation commitments. The salt scrubbed by this process may not all meet the safeguards termination limits and could need some subsequent processing prior to disposition.

The salt scrub process for pyrochemical salts and subsequent shipment of resultant scrub alloy to Savannah River Site are shown in **Figure C–29**. Because of differences in salt composition, each of the salt types would be processed separately; however, the process steps are the same for each. The feed materials would be sorted and batched in preparation for salt scrub. The salts would be scrubbed to remove as much plutonium as possible. This description assumes all salts would be scrubbed as a bounding condition;

certain lots of material may be unsuitable for this process due to age, condition, or low plutonium content, and would require alternative processing.

After salt scrub, the salts would be re-batched for pyro-oxidation. The salts would be pyro-oxidized to convert any reactive metals to oxides. After pyro-oxidation, the salts would be removed from the glovebox and nondestructively assayed for accountability purposes, packaged in the final transport/storage container, and placed in interim storage. The scrub alloy would also be removed from the glovebox, nondestructively assayed for accountability purposes, and packaged in the final transport/storage container and stored, if necessary, until it can be shipped to Savannah River Site by safe secure trailer or other DOE-approved transport, as appropriate.

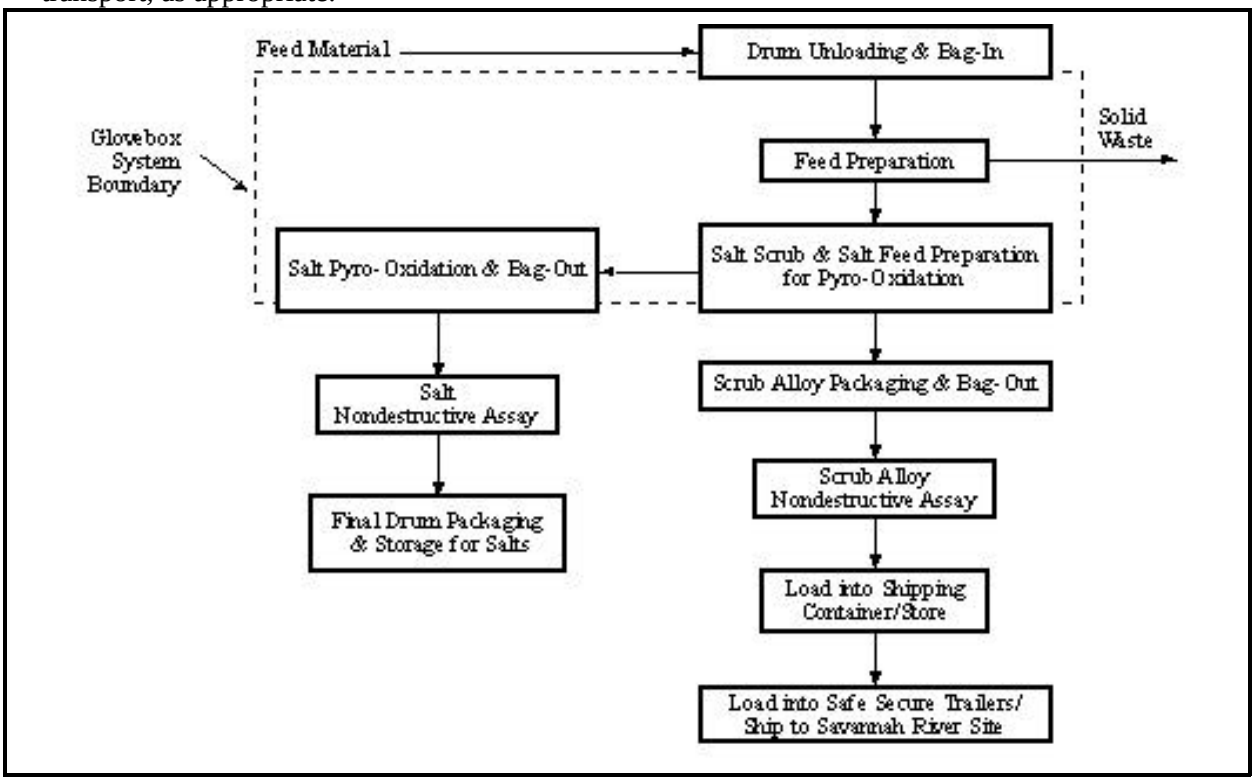


Figure C–29 Salt Scrub Process and Subsequent Shipment of Resultant Scrub Alloy to Savannah River Site

Detailed Process Description

As required, drums would be manually transferred into a contamination control enclosure and unpacked. This step would be to contain any contamination on the outside of the inner package which could result from radiolysis or physical damage to the package during storage. Any unnecessary packaging materials would be removed to limit the amount of packaging introduced into the feed preparation glovebox. All of these individual containers, after examination and/or repackaging in the contamination control enclosure, would be bagged into the feed preparation glovebox.

The feed materials would be introduced into the glovebox, one stream at a time, and the IDC verified. The salt would be removed from the original container, weighed, and batched with the appropriate amount of metal reductants and matrix (e.g., gallium and calcium metal). The quantities of gallium and calcium used would be dependent on the plutonium and americium content. The maximum batch size will be 2.5 kg (5.5 lb) of bulk residue, which produces approximately 200 g (7 oz) plutonium metal. Combustible

packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustibles handling process. Other materials would be bagged out and managed appropriately.

Although, in the salt scrub process, an aluminum/magnesium alloy has been used in the past and may be used in specific cases, the newer gallium/calcium alloy system would lower the overall radiation levels, since alpha-neutron reactions would be minimized. The charge, containing the salt/metal mixture, would be placed into a furnace and heated at 800°C (1,470°F) for 2 hours (8-hour cycle time). During heating, the molten salt/metal mixture would be mechanically stirred. The furnace would then be allowed to cool, and the crucible would be removed from the furnace and allowed to completely cool before breakout. The scrub alloy button and the plutonium-depleted salts would be removed from the crucible and the crucible would be discarded. The salts would be either stored in-line or batched into magnesium oxide or other crucibles and sent to pyro-oxidation by chain conveyer.

Once the crucible has been loaded with salt feed, it would be placed in a glovebox furnace and heated to approximately 800°C (1,470°F) with sodium carbonate as a reagent for 2 to 3 hours, stirring continuously (8-hour cycle time). The product would be a stabilized plutonium salt matrix. Pyro-oxidation could be applied to both sodium chloride-potassium chloride and calcium chloride matrices. This process would convert reactive metals (i.e., calcium, sodium, and potassium) to oxides. When the furnace has cooled to below 100°C (212°F), the crucible would be removed from the furnace. During the heating, stirring, and cooling phases, argon would flow through the furnace. During the last part of the heating phase, argon would be replaced by a mixture of air and argon.

Once the crucible has been removed from the furnace, it would be allowed to completely cool before breakout. The salt matrix would then be removed from the crucible and the crucible would be discarded. The material would be batched to 9.1 kg (20.0 lb) of total residue (based on an estimated maximum weight to be handled in a glovebox), placed into a container, bagged from the glovebox, and placed in a convenience container for safe handling. If metal crucibles are used, the pyro-oxidized salt would remain in the crucibles and be sealed and bagged out directly in nominal 2.5-kg (5.5-lb) bulk (net) batches.

Nondestructive assay would be performed to ensure requirement limits are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data are obtained. Assayed product packages would be selected for final packaging to minimize the number of shipping containers required to be shipped to WIPP. Selected packages would be loaded into an inner container and sealed before placing of the container into the final outer shipping container.

The scrub alloy buttons would be weighed and placed in a dissolvable (mild steel) container. The containers would be crimp-sealed, weighed, and bagged out of the glovebox line, using special dissolvable, nylon bags. After bag-out, two smaller cans would be placed in one tall dissolvable can and sealed. Although aluminum containers have been used in the past, mild steel cans would be used on all future shipments.

Nondestructive assay would be performed and calorimetry may be used for determining a heat signature for a shipping package. Packages would be loaded into Type 6M shipping containers and transferred to interim vault storage or the shipping dock. There would be one can in each shipping container. The shipping containers would be cleaned and surveyed for contamination before transfer to either interim vault storage or the shipping dock. The loaded Type 6M containers would be picked up at the process building or interim vault storage and transferred to the shipping facility, where they would be loaded into a safe secure trailer by forklift. Safe, secure trailer transported shipments to Savannah River Site would be

required for the newly-created scrub alloy. The distance from Rocky Flats to Savannah River Site is approximately 2,620 km (1,625 mi.).

❒ **Purex Processing at Savannah River Site of Newly Created Scrub Alloy**

The scrub alloy would be dissolved in the Savannah River Site F- or H-Canyon. The plutonium would be separated from americium and aluminum using the solvent extraction technology. The plutonium would be converted to metal or oxide prepackaged into cans that are placed in the FB- or HB-Line. That metal or oxide would be transferred to Savannah River Site's FB-Line or 235-F vault until the Actinide Packaging and Storage Facility vault is complete, packaging completed (outer container) to meet DOE-STD-3013-96 (DOE 1996c) and stored until decisions are made on fissile material disposition. This process is currently in operation and no changes to the process are required due to salt scrub alloy. The salt scrub alloy Purex processing to metal or oxide at Savannah River Site is shown in **Figure C–30**.

Detailed Process Description

The shipping containers received from Rocky Flats would be unloaded, confirmatory measurements made and placed in a vault-like room in 235-F. Twelve shipping containers at a time would be removed from storage and transported to the F- or H-Canyon crane maintenance area where the shipping containers would be opened up and the cans loaded into a dissolver tube. The dissolver tube would then be loaded into a dissolver by remote control. Twelve cans make up one dissolving batch.

Heated nitric acid in the tank dissolves the salt scrub alloy, resulting in a solution containing americium, chloride, aluminum, magnesium, and plutonium. The plutonium would be recovered and purified by solvent extraction; the impurities remain in the aqueous stream. The waste liquid containing americium, aluminum, and residual plutonium would be transferred from the Savannah River Site canyon facility to the Savannah River Site high-level waste system. The plutonium product solution would be transferred to canyon hold tanks for later transfer to FB- or HB-Line.

The FB-Line process would include concentration of plutonium by cation exchange, precipitation of plutonium as a trifluoride, recovery of the trifluoride by filtration, drying of trifluoride in an oxygen atmosphere, and reduction with calcium metal to form plutonium metal buttons. The sand, slag, and crucible generated from button reduction would be dissolved in F-Canyon. The HB-Line process would include concentration of plutonium through anion exchange, precipitation of plutonium as plutonium oxalate, recovery of the oxalate by filtration, drying and calcining the oxalate, converting it to plutonium oxide. The buttons and oxide would be prepackaged into cans which would be placed in an F area vault for temporary storage. The cans would then be removed from the F area vault, placed into shipping containers, and transported to the Actinide Packaging and Storage Facility. At the Actinide Packaging and Storage Facility, the cans would be removed from the shipping containers, packaged into an outer 3013 container, and placed into the vault for long-term storage pending disposition in accordance with decisions reached under the *Surplus Plutonium Disposition Environmental Impact Statement*. Any plutonium separated would be disposed of using an immobilization process.

C.6.6 Acid Dissolution with Plutonium Oxide Recovery of Fluoride and Sludge Residues

The acid dissolution of either fluoride or sludge residues would involve dissolution of the residues, followed by precipitation and filtration of plutonium oxalate, and calcination to plutonium oxide for storage pending a final disposition decision. The filtrate from the oxalate precipitation would be treated with magnesium hydroxide to precipitate the plutonium remaining in the solution. That precipitate would then be filtered,

calcined, repackaged, and placed in interim site storage before being shipped to WIPP. The dissolution process would be conducted inside gloveboxes located in Room 3701 of Building 371.

The acid dissolution/plutonium oxide recovery process consisting of dissolving the plutonium contained in fluorides or sludges, filtering the solution, and precipitating and calcining a plutonium oxalate, is considered to be a proven technology. The process to be used for the limited quantities of materials identified in these categories would be consistent with equipment and activities that can be performed in the neutralize-dry process area. Thus, the capability for Rocky Flats is currently being installed to support the disposition of below-safeguards termination limit materials, and should be available several months after the issuance of the EIS. However, the use of this equipment for acid dissolution would generally be preceded by the neutralize-dry processing of the combustible residues required by the Defense Nuclear Facilities Safety Board Recommendation 94-1 stabilization program, and may not be able to start until 4 years after issuance of the Record of Decision.

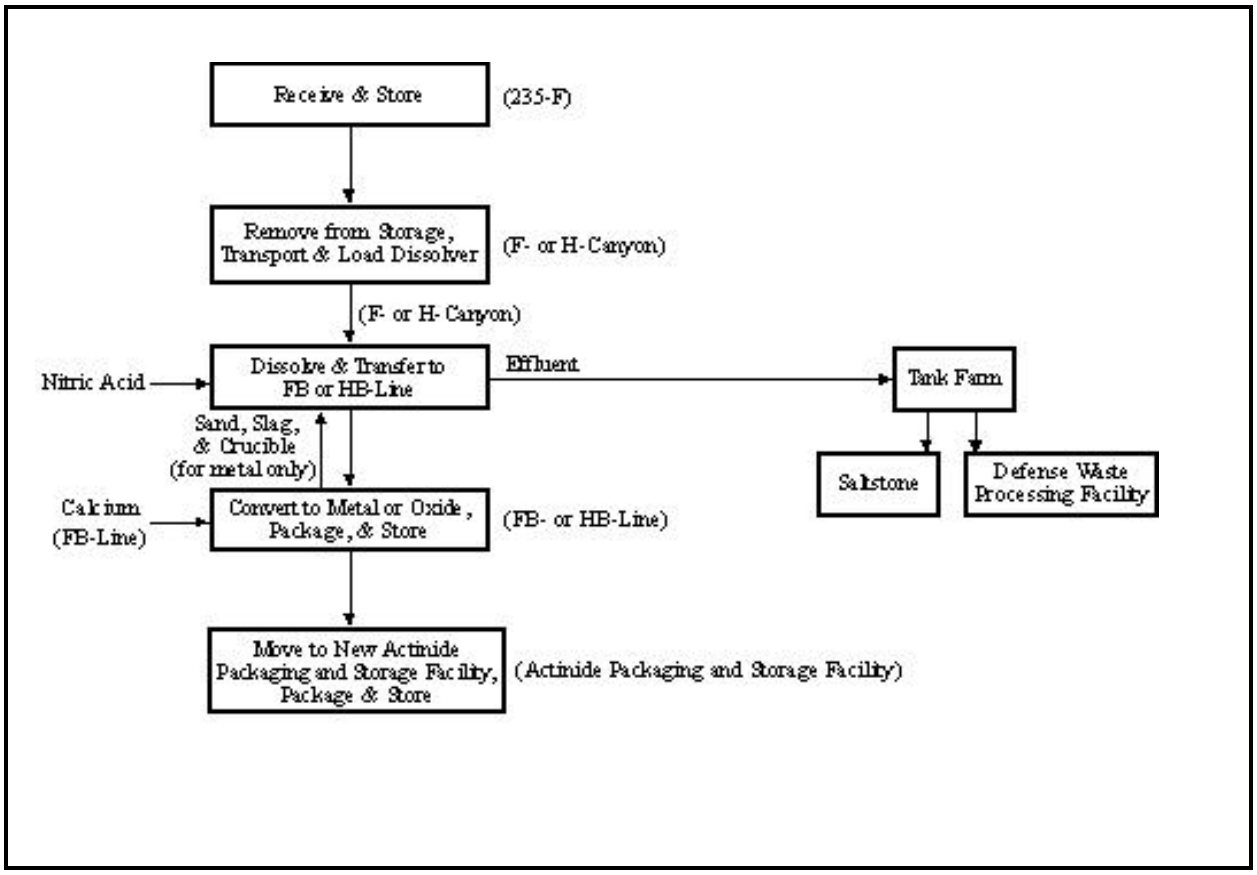


Figure C–30 Salt Scrub Alloy Purex Process at Savannah River Site

The plutonium residue acid dissolution process is shown in **Figure C–31**. The feed materials would be unpacked and batched for acid dissolution. The dissolved residues would be sent through precipitation to form plutonium oxalate precipitate in slurry form, which would then be filtered to separate the effluent solution from the precipitate. The oxalate would be calcined, nondestructively assayed, calcined again for long-term storage, again nondestructively assayed, and then packaged for storage. Magnesium hydroxide would be mixed into the oxalate precipitation effluent to precipitate the remaining plutonium, and the effluent filtered to form magnesium hydroxide and effluent. The magnesium hydroxide would be calcined and packaged. The packaged magnesium hydroxide product would be removed from the glovebox and nondestructively assayed for

accountability purposes, packaged in the final transport/storage container, and placed in interim storage. The last filtration effluent would be sent for evaporation at the Rocky Flats wastewater treatment facility.

❒ Detailed Process Description

The residue feed would be introduced into the glovebox, and the IDC would be verified. The materials would then be removed from the containers and batched to a maximum of 200 g (7 oz) of plutonium in preparation for nitric acid dissolution. Combustible packaging materials from the individual containers would be bagged out of the glovebox and sent to a combustible handling process. Other unwanted materials would be bagged out of the glovebox and managed appropriately.

The contents of the residue cans would be transferred to one of two heated stirrers. The operator would add 7N nitric acid (HNO_3) and 60 percent aluminum nitrate ($Al(NO_3)_3$) solution to each dissolver before stirring. $Al(NO_3)_3$ would be added to complex residue ions during dissolution. The slurry would be heated

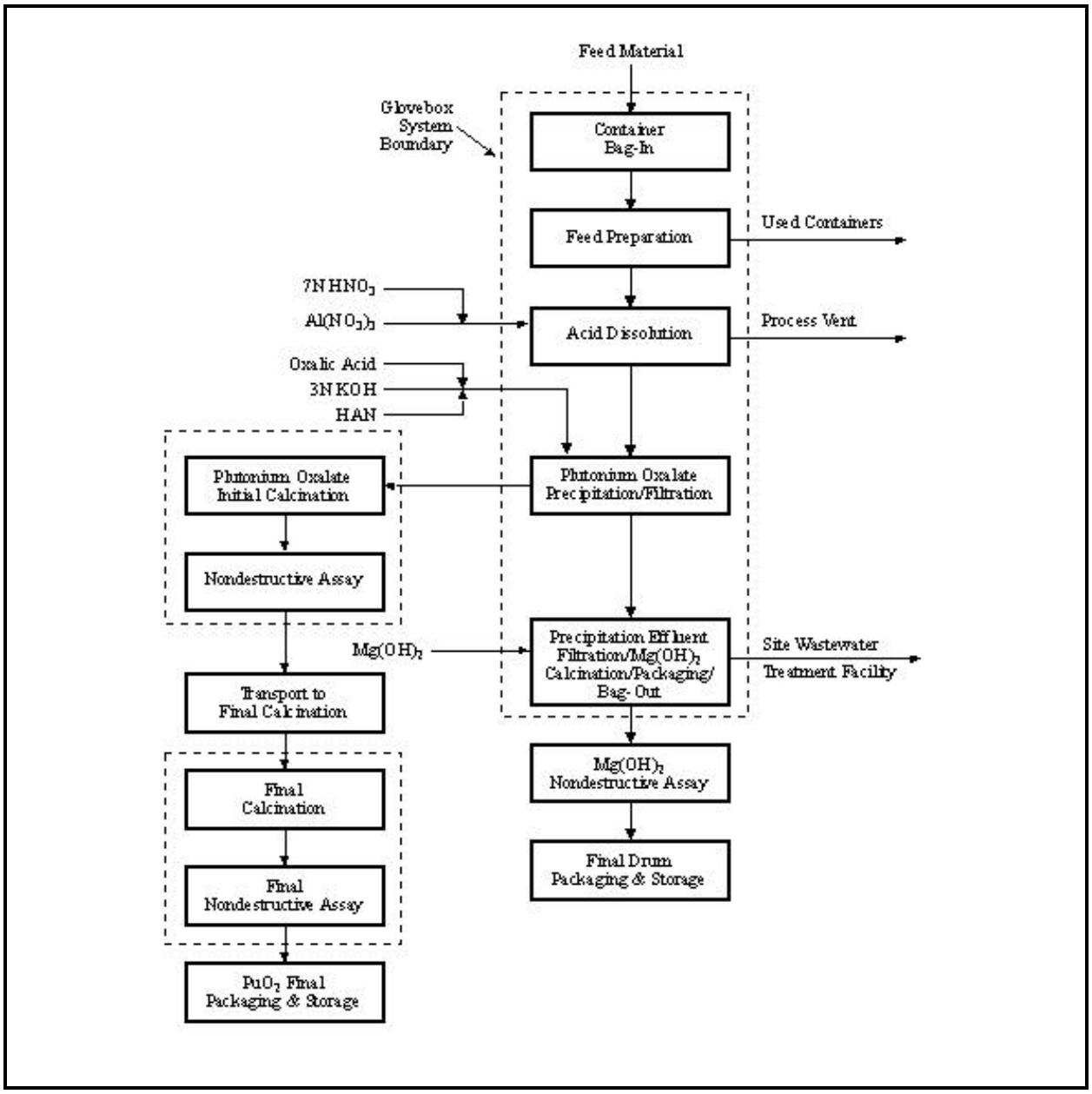


Figure C–31 Acid Dissolution Process for Fluoride and Sludge Residues

to approximately 80°C (176°F) and stirred until dissolution is achieved. Vented fumes would be cooledin a condenser, and then piped to the process vent system. The batch would be filtered to remove any undissolved solids and then split into two equal amounts and transferred to the adjacent heated stirrers for precipitation.

For plutonium oxalate precipitation, 3N potassium hydroxide (KOH) would be added to each can to adjust the normality to 0.75N nitric acid. Hydroxylamine nitrate (HAN) would then be added as a 1.9M solution to adjust the plutonium valence to +3. After these adjustments have been made, solid oxalic acid would be added to form plutonium oxalate precipitate. The solution would be heated to approximately 80°C (176°F) and stirred to form a slurry.

The slurry from the two stirrer assemblies would be poured onto an R-4 filter. Filtration of plutonium oxalate would be achieved by pulling a vacuum through the filter and drawing effluent liquids into a filtrate tank. The plutonium oxalate precipitate would be scooped into a filter boat in preparation for calcining.

The plutonium oxalate would require calcining at 450°C (840°F) to convert the oxalate into the oxide form. In this process, the filter boat would be placed on a pneumatic lift, placed into the calcination furnace, and the precipitate would be heated to 450°C (840°F). Glovebox air would be drawn down through the precipitate at a rate of approximately 0.10 m^3 (3.5 ft^3) per minute during the heating cycle. After a cooling cycle, the calcined oxide would be transferred from the filter boat back into a can, batched to 1,000 g (2.2 lb), sealed, and sent to calorimetry.

The plutonium oxide can would be assayed for plutonium content based on its rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. This activity would be required to maintain accountability within the acid dissolution material balance area. After assay, the containers would be ready for final calcination. The cans containing the plutonium oxide would be placed into appropriate outer containers and transferred to the Building 371 loading dock. The containers would then be transported to the Building 707 loading dock by intra-site truck transportation, and moved to appropriate vault storage pending final calcination.

The plutonium oxide cans would be transferred from the Building 707 storage vault to Module J and bagged into the plutonium stabilization and packaging system. The plutonium oxide would be removed from the cans, placed into furnaces, and calcined at 1,000°C (1,830°F) for 8 hours. The material, now suitable for long-term storage or transportation, would be weighed, characterized, and placed into a 3013 inner container. This container would then be removed from the glovebox by the bagless transfer process and sent to calorimetry. The plutonium oxide package would be assayed for plutonium content based on its rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be placed into vault storage, pending a final disposition decision. Any plutonium separated would be disposed of using an immobilization process.

Magnesium hydroxide would be added to the effluent liquid in the filtrate tank from the precipitation filtration step, and the tank would be mixed by sparging. The liquid and precipitate would then be drained onto an R-4 filter. Filtration would be achieved by pulling a vacuum through the R-4 filter and drawing effluent liquids into the transfer tank. The magnesium hydroxide precipitate would then be scooped into a filter boat in preparation for calcining. The magnesium hydroxide would be calcined at 450°C (840°F). In this process, the filter boat would be placed on a pneumatic lift, placed into the calcination furnace, and the precipitate would be heated to 450°C (840°F). Glovebox air would be drawn down through the precipitate at a rate of approximately 0.10 m^3 (3.5 ft^3) per minute during the heating cycle. After a cooling cycle, the calcined hydroxide would be transferred from the filter boat back into a can, batched to 9.1 kg (20 lb), sealed, and bagged out into convenience cans.

Nondestructive assay of the magnesium hydroxide would be performed to ensure requirements limit are met and to obtain data to ensure that required accountability procedures are followed. Nondestructive assay methods would be selected to ensure that the best accountability data are obtained. Assayed product packages would be selected for final packaging to minimize the number of shipping containers and placed in interim storage before being shipped to WIPP. Selected packages would be loaded into an inner container and sealed before placing the container into the final outer shipping container.

C.6.7 Acid Dissolution with Plutonium Oxide Recovery at Los Alamos National Laboratory with Preprocessing at Rocky Flats for Direct Oxide Reduction Salts

Acid dissolution processing of direct oxide reduction salts has been proposed at Los Alamos National Laboratory. This technology option requires salt preprocessing at Rocky Flats.

❒ **Preprocessing at Rocky Flats**

The preprocessing of these salts at Rocky Flats is the same as given in Section C.6.4.2 for preprocessing prior to water leach.

❒ **Acid Dissolution with Plutonium Oxide Recovery at Los Alamos National Laboratory**

The acid dissolution of direct oxide reduction salts at Los Alamos National Laboratory would involve dissolution of the salts, followed by solvent extraction to separate the plutonium from the salts, oxalate precipitation, and calcination to convert the plutonium compound into plutonium oxide, and hydroxide precipitation and calcination to convert the lean residues to filter cake. The hydroxide filtrate would be processed in the Liquid Waste Treatment Facility. The resulting products would be a lean transuranic salt waste to be shipped to WIPP and plutonium oxide to be stored in TA-55 pending a final disposition decision. The entire acid dissolution process would be conducted inside gloveboxes located in the Los Alamos Plutonium Facility in Technical Area 55. This process is considered to be a proven technology.

The acid dissolution process is shown in **Figure C-32**.

The feed materials would be unpacked and sorted in preparation for acid dissolution to dissolve the salts. After acid dissolution, the plutonium-bearing solution would go through solvent extraction, generating plutonium in the four valence state, which would then be converted prior to the precipitation step to a valence of three, making plutonium (III) oxalate. The plutonium (III) oxalate would then be converted to plutonium oxide by calcination. The plutonium oxide would be nondestructively assayed for accountability purposes, re-calcined, and stored pending a final disposition decision. The waste solutions from solvent extraction and oxalate precipitation would go through hydroxide precipitation and calcination. Wastewater from this would then be sent to the Liquid Waste Treatment Facility and the magnesium hydroxide would be packaged and nondestructively assayed for accountability purposes. The magnesium hydroxide would be packaged in the final transport/storage container and moved into interim storage pending disposal at WIPP.

Detailed Process Description

As required, shipping containers would be manually transferred from storage into a materials management room. The materials management room is designed to control airflow in the event of an inner container failure. The shipping container would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the inner containers would be transferred to the glovebox. If the integrity of the inner container has been compromised, it would be overpacked with a plastic bag, prior to transfer to the glovebox.

The primary feed for this process would be direct oxide reduction salts. Once the cans have been bagged into the glovebox, the IDCs would be verified. First, the tall cans would be opened, and then the individual small cans, each containing about 2,200 grams of salt, would be opened, and the contents placed into a dissolver.

The salt would be treated in the acid dissolution process on a batch basis. Acid dissolution would consist of mixing equal weights of water and salts, turning on both vacuum and argon sparging for the dissolver, and adding 12M hydrochloric acid in 200-ml increments to the process. Hydrochloric acid would be added in the amount of milliliters equal to four times the weight of the salts. After 30 to 45 minutes, the solution would be filtered and the dissolver would be washed out with an equal amount of water as was added previously. The wash water would be sent to the Liquid Waste Treatment Facility. The plutonium-bearing product solution would be sent to the solvent extraction feed tank.

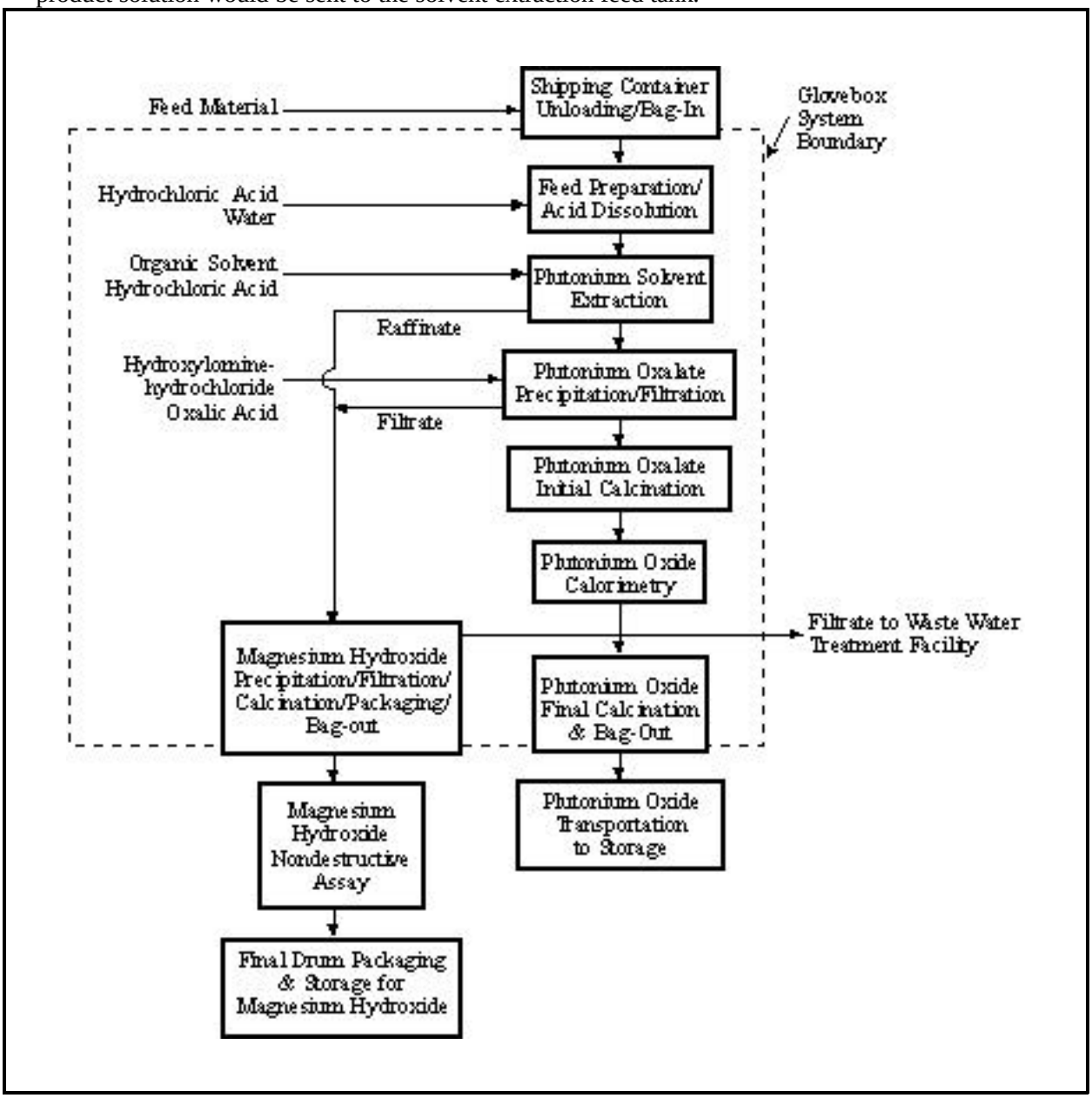


Figure C–32 Acid Dissolution Process for Direct Oxide Reduction Salts at Los Alamos National Laboratory

An oxidizer, in the form of sodium chlorite and water, would be added to the acid dissolution product solution, now called the feed solution, in the four-valence tank, while continuously mixing. Based upon the amount of chloride present, concentrated hydrochloric acid would then be added while continuously mixing the tank, to adjust the molarity to between 6 and 8M. After adjusting the molarity, the organic phase

(composed of 70% dodecane and octanol and 30% tributylphosphate) flow would be turned on and then the feed solution from acid dissolution would be fed into the annular centrifugal contactors. The plutonium and americium would move into the organic phase, and the resulting lean acid phase would exit the contactors and be sent to the raffinate catch boat. The strip solution composed of 0.2M hydrochloric acid would then be fed into the contactors, and the plutonium would move from the organic phase into the dilute acid phase. The resulting product solution would exit the contactors and be sent to the product catch boat. Vacuum would be used to pull the raffinate and product solutions to their respective tanks.

The plutonium-rich solution coming from solvent extraction would be transferred to the precipitation feed tanks, where it would be converted to the three-valence state using hydroxylamine-hydrochloride. The batched material would be placed in glass agitated-precipitator columns, and oxalic acid would be added. After mixing for at least 30 minutes, the supernatant would be decanted and filtered into a holding tank. The plutonium oxalate would be drained into a filter boat. The tank would be washed with 0.1M oxalic acid and drained through the filter. The oxalate would dry on the filter and then be transferred to a platinum-lined furnace can. The filtrate would be sampled and sent to hydroxide precipitation.

The furnace can containing the plutonium oxalate would be placed into a calciner and heated to approximately 400°C (750°F) for an hour to decompose the plutonium oxalate to plutonium oxide and carbon dioxide. The plutonium oxide would then be consolidated into slip-lid cans, weighed, and transferred to calorimetry for nondestructive assay. The plutonium oxide would be assayed for plutonium content based on the rate of thermal generation using calorimeters and gamma-ray isotopic spectrometer equipment. After assay, the containers would be ready for final calcination.

Plutonium oxide from the nondestructive assay step would be removed from the cans, batched, placed into furnaces, and calcined at 1,000°C (1,830°F) for 4 hours. The material, now suitable for storage or transportation, would be weighted, characterized, and placed into a 3013 container. The material would be bagged out and stored at TA-55 pending a final disposition decision. Any plutonium separated would be disposed of using an immobilization process.

The raffinate from solvent extraction and the filtrate from oxalate precipitation would be collected in separate holding tanks in preparation for plutonium removal by precipitation. Magnesium hydroxide (30% by weight) and raffinate or filtrate would be mixed in the precipitation tanks by sparging. The liquid and precipitate would then be drained onto an R-4 filter. Filtration would be achieved by pulling a vacuum through the R-4 filter and drawing effluent liquids into the transfer tank. The magnesium hydroxide precipitate would then be scooped into a filter boat in preparation for calcining. The magnesium hydroxide would be calcined at 450°C (840°F). After a cooling cycle, the calcined hydroxide would be transferred from the filter boat back into a can, batched to 9.1 kg (20 lb), sealed, and bagged out into convenience cans and nondestructively assayed. The remaining filtrate would be sent to the Liquid Waste Treatment Facility in Technical Area 55. Assayed product packages would be selected for final packaging to minimize the number of shipping containers required to be shipped to WIPP. Selected packages would be loaded into a pipe component and then the piped component would be loaded into the final outer shipping container. One pipe component would be placed into each 208-L (55-gal) drum for shipment to WIPP.

C.7 DETAILED PROCESS DESCRIPTIONS FOR COMBINATION OF PROCESSING TECHNOLOGIES

The process descriptions for residues that have combined, including blending and repackaging (combination) technologies, are essentially the same as the process descriptions given for No Action and for Processing without Plutonium Separation (Sections C.4 and C.5, respectively), except for the application of a variance to safeguards termination limits. Explanations for each of the combination processing technologies are provided in this section.

The variances to safeguards termination limits include all residues that have a plutonium content of less than or equal to 10 percent. Residues above 10 percent plutonium would be combined with below 10 percent plutonium residues to maintain the 10 percent limit on plutonium content; however, if this type of blending is insufficient to reach 10 percent plutonium, the above 10 percent plutonium residues may be hand-blended with enough virgin material to reach the 10 percent limit on plutonium content.

C.7.1 Combination Process for the Calcination/Cementation of Ash Residues

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the ash category have received a variance to safeguards termination limit, and are addressed in this process description.

The combination process for the calcination/cementation of ash residues calcines, sand, slag and crucible, and inorganic ash residues. Then, along with the graphite fines, all the ash residue would be blended to no more than 10 percent plutonium and cemented, if necessary. The material would then be packaged for interim site storage and ultimate shipment to WIPP. This process would be conducted in Building 707.

The process steps would include drum unloading and bag-in, feed preparation for calcination and calcination, feed preparation (including blending) for cementation, in-line nondestructive assay, mixing of ash with cement, cement curing and bag-out, and final drum packaging and storage.

The description of the combination process for the calcination/cementation of ash residues is similar to the description of the calcination and cementation of ash residues process in the No Action Alternative, except that the graphite fines are not calcined, blending to 10 percent plutonium occurs, and cementation would only be performed if necessary.

C.7.2 Combination Process for the Repackaging of Ash Residues

The residues in the EIS would be divided into categories based upon similar applicable process technologies. The residues in the ash category have received a variance to the safeguards termination limit. In addition, stabilization may not be necessary, which would allow direct repack into pipe components and into drums for shipment to WIPP. The ash residues receiving a variance to the safeguards termination limit and not needing stabilization are addressed in this process description.

Under the combination concept for the repackaging of ash residues, incinerator ash; graphite fines; sand, slag, and crucible; and inorganic ash residues would be blended to no more than 10 percent plutonium and repacked into pipe components for shipment to WIPP. The process would be conducted within a glovebox located in Module A, Building 707.

The combination process for the repackaging of ash residues is shown in **Figure C-33**. The process steps would include drum unloading and bag-in, feed preparation (including blending), repackaging, and bag-out.

The packaged material would be nondestructively assayed for accountability purposes, and packaged into pipe components and then into drums for shipment to WIPP.

❒ **Detailed Process Description**

Drums with the capacity of 208-L (55-gal) would be manually transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox. The containers, including outer packaging materials, would be removed from the drum and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag prior to transfer to the glovebox.

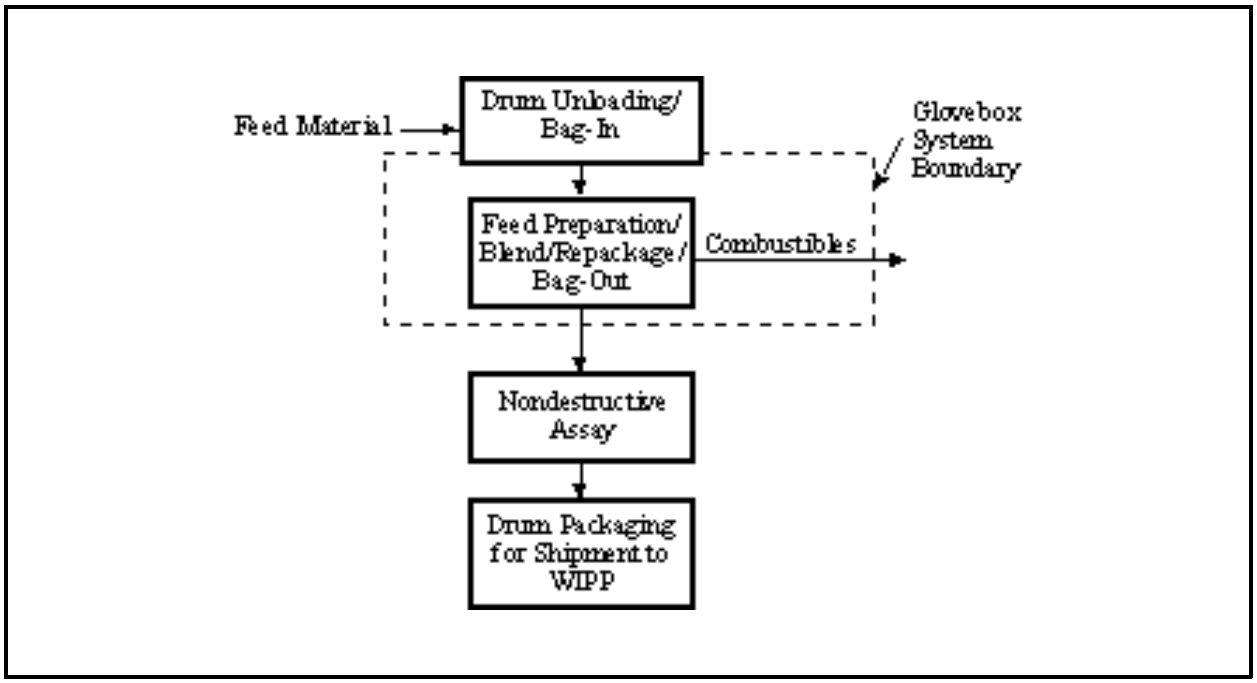


Figure C–33 Combination Process for the Repackaging of Ash Residues

The feed material would be introduced into the glovebox and the IDC verified. The individual packages would be opened, sorted, blended to no more than 10 percent plutonium, and placed into 8.2-L (2.2-gal) containers. The containers would then be bagged from the glovebox. Combustible packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustible handling process. Other materials would be bagged out and managed appropriately.

Nondestructive assay would be performed and the assayed and repackaged residue containers would be loaded into a pipe component, one container each, which would be staged inside of a 208-L (55-gal) drum. These drums would be shipped to WIPP immediately.

C.7.3 Combination Process for the Pyro-Oxidation of Molten Salt Extraction/Electrorefining Salts

The residues in the EIS would be divided into categories based upon similar applicable process technologies. The residues in the molten salt extraction/electrorefining salt category have received a variance to the

safeguards termination limit. The molten salt extraction/electrorefining salts that have received this variance are addressed in this process description.

The combination process for the pyro-oxidation of molten salt extraction/electrorefining salts pyro-oxidizes electrorefining salts and molten salt extraction salts to convert reactive metals to oxides. The resulting products would be blended to below 10 percent plutonium and would be packaged for interim site storage and ultimate shipment to WIPP. The pyro-oxidation process would be conducted inside gloveboxes located in Module A, Building 707.

The process steps would include drum unloading and bag-in, feed preparation, blending, and staging for pyro-oxidation, pyro-oxidation and bag-out, nondestructive assay, and drum packaging for interim site storage.

The description of the combination process for the pyro-oxidation of molten salt extraction/electrorefining salts would be similar to the process description for the pyro-oxidation of pyrochemical salts, except that the salts would be loaded into pipe components for ultimate shipment to WIPP. (See Section C.4.2.)

C.7.4 Combination Process for the Repackaging of Molten Salt Extraction/Electrorefining Salts

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the molten salt extraction/electrorefining salt category have received a variance to the safeguards termination limit. In addition, stabilization may not be necessary, thereby allowing direct repack into pipe components and into drums for shipment to WIPP. The molten salt extraction/electrorefining salts receiving a variance to the safeguards termination limit and not needing stabilization are addressed in this process description.

Under the combination concept for the repackaging of molten salt extraction/electrorefining salts, electrorefining salts and molten salt extraction salts would be blended to no more than 10 percent plutonium and repacked into pipe components for shipment to WIPP. The repack process would be conducted inside gloveboxes located in Module A, Building 707.

The combination process for the repackaging of molten salt extraction/electrorefining salts is shown in **Figure C-34**. The process steps would include drum unloading and bag-in, feed preparation (including blending), repackaging, and bag-out. The packaged material would be nondestructively assayed for accountability purposes, and packaged into pipe components and then into drums for shipment to WIPP.

❒ **Detailed Process Description**

Drums with the capacity of 208-L (55-gal) would be manually transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox. The containers, including outer packaging materials, would be removed from the drum and bagged into the glovebox. If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag prior to transfer to the glovebox.

The two primary feeds for this process would be: 1) electrorefining salts, and 2) molten salt extraction salts. These materials would be introduced into the glovebox, one stream at a time, and the IDC verified. The individual packages would be opened, sorted, blended to no more than 10 percent plutonium, and placed into 8.2-L (2.2-gal) containers. The containers would then be bagged from the glovebox.

Combustible packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustible handling process. Other materials would be bagged out and managed appropriately.

Nondestructive assay would be performed and the assayed and repackaged salt containers would be loaded into a pipe component, one container each, which would be staged inside of a 208-L (55-gal) drum. These drums would be shipped to WIPP immediately.

C.7.5 Combination Process for the Pyro-Oxidation of Direct Oxide Reduction Salts

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the direct oxide reduction salt category have received a variance to the safeguards termination limit. The direct oxide reduction salts that have received this variance are addressed in this process description.

The combination process for the pyro-oxidation of direct oxide reduction salts pyro-oxidizes direct oxide reduction salts to convert reactive metals to oxides. The resulting products would be blended to below 10 percent plutonium and would be packaged for safe interim site storage and ultimate shipment to WIPP. The pyro-oxidation process would be conducted inside gloveboxes located in Module A, Building 707.

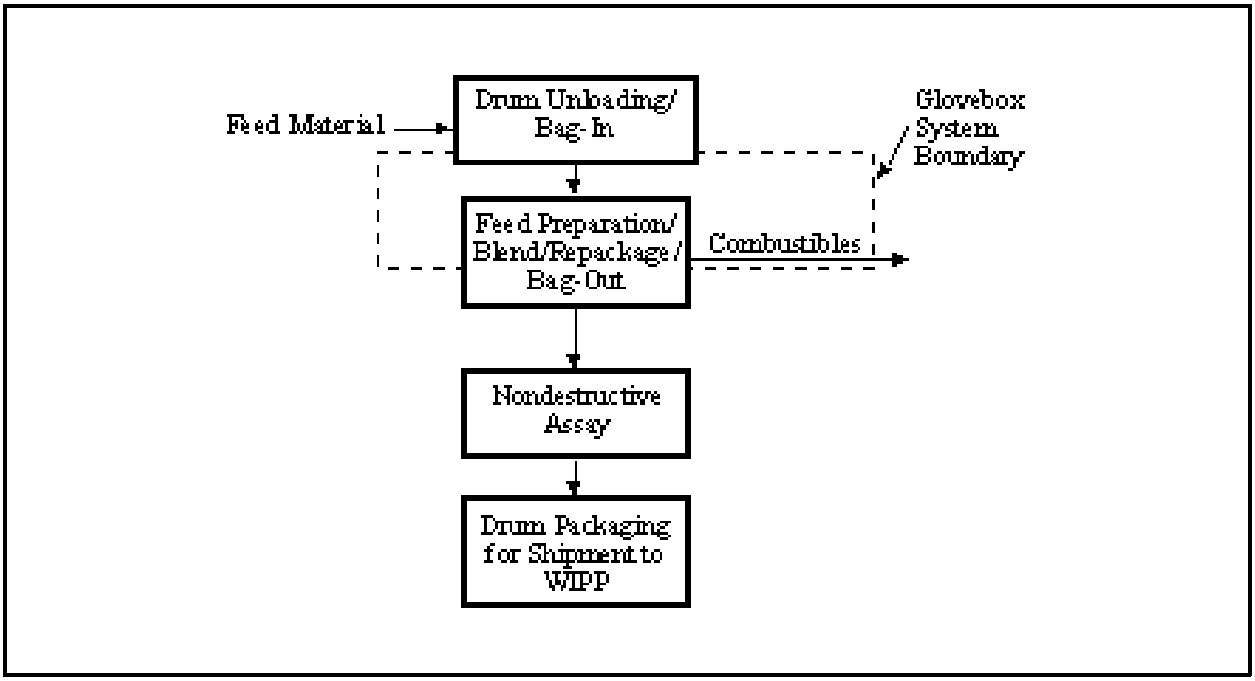


Figure C–34 Combination Process for the Repackaging of Molten Salt Extraction/Electrorefining Salts

The process steps would include drum unloading and bag-in, feed preparation, blending, and staging for pyro-oxidation, pyro-oxidation and bag-out, nondestructive assay, and drum packaging for interim site storage.

The description of the combination process for the pyro-oxidation of direct oxide reduction salts is similar to the pyro-oxidation of pyrochemical salts process description, except that the salts would be loaded into pipe components for ultimate shipment to WIPP. (See Section C.4.2.)

C.7.6 Combination Process for the Repackaging of Direct Oxide Reduction Salts

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the direct oxide reduction salt category have received a variance to the safeguards termination limit. In addition, stabilization may not be necessary, thereby allowing direct repack into pipe components and into drums for shipment to WIPP. The direct oxide reduction salts receiving a variance to the safeguards termination limit and not needing stabilization are addressed in this process description.

Under the combination concept for the repackaging of direct oxide reduction salts, direct oxide reduction salts would be blended to no more than 10 percent plutonium and repacked into pipe components for shipment to WIPP. The repack process will be conducted inside gloveboxes location in Module A, Building 707.

The combination process for the repackaging of direct oxide reduction salts is shown in **Figure C-35**. The process steps would include drum unloading and bag-in, feed preparation, repackaging (including blending), and bag-out. The packaged material will be nondestructively assayed for accountability purposes, and packaged into pipe components and then into drums for shipment to WIPP.

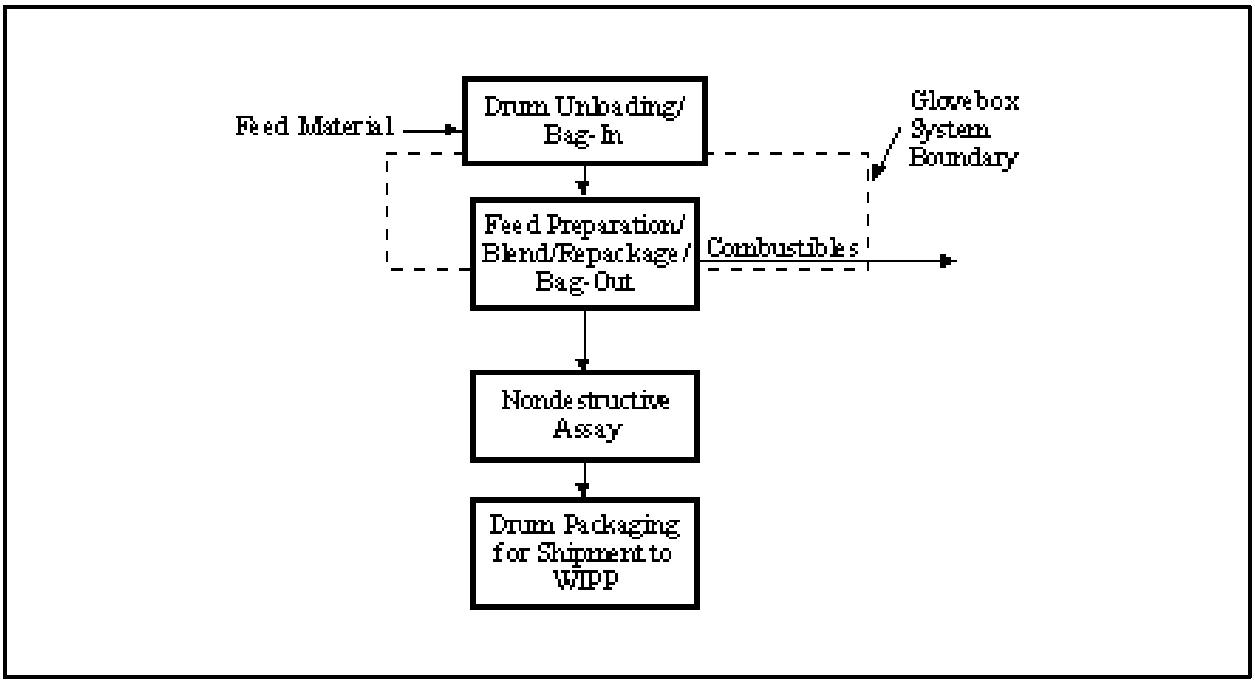


Figure C–35 Combination Process for the Repackaging of Direct Oxide Reduction Salts

❒ **Detailed Process Description**

Drums with the capacity of 208-L (55-gal) would be manually transferred from storage into a contamination control enclosure and unpacked. The contamination control enclosure is designed to control airflow in the event of a bag failure within a drum. The drums would be opened and the integrity of the packaging would be checked. If the packaging has not been compromised, the containers would be transferred into the glovebox. The containers, including outer packaging materials, would be removed from the drum and bagged into the glovebox.

If the integrity of the packaging has been compromised, the package would be overpacked with a new plastic bag prior to transfer to the glovebox.

The primary feed for this process would be direct oxide reduction salts. These materials would be introduced into the glovebox and the IDC verified. The individual packages would be opened, sorted, blended to no more than 10 percent plutonium, and placed into 8.2-L (2.2-gal) containers. The containers would then be bagged from the glovebox. Combustible packaging materials from the individual packages would be bagged out of the glovebox and sent to a combustible handling process. Other materials would be bagged out and managed appropriately.

Nondestructive assay would be performed and the assayed and repackaged salt containers would be loaded into a pipe component, one container each, which would be staged inside of a 208-L (55-gal) drum. These drums would be shipped to WIPP immediately.

C.7.7 Combination Process for the Neutralization and Drying of Aqueous-Contaminated Combustibles

The materials in the aqueous-contaminated combustible residues category have received a variance to the safeguards termination limit. The processing of these residues is addressed in this technology description.

The combination process for the neutralization and drying of aqueous-contaminated combustible residues would remove nitric acid from the organic matrix, eliminating a possibly unstable condition. The residues-consist of materials, such as cloth, paper, rags, coveralls, rubber, wood, and other miscellaneous materials, some of which are above the safeguards termination limit for combustibles. The application of a variance to the safeguards termination limit would allow shipment of this material to WIPP for disposal as transuranic waste. This process would be conducted in Room 3701 of Building 371.

The process steps would include drum unloading and bag-in, feed preparation, neutralization and decant/filtration, oven drying, packaging and bag-out, nondestructive assay, and drum transfer to interim site storage.

The description of the combination process for the neutralization and drying of aqueous-contaminated combustibles is identical to that given in Section C.4.3, Neutralization and Drying of Aqueous-Contaminated Combustibles.

C.7.8 Combination Process for the Thermal Desorption and Steam Passivation of Organic-Contaminated Combustibles

The materials in the organic-contaminated combustible residues category have received a variance to the safeguards termination limit. The processing of these residues is addressed in this technology description.

The combination process for the thermal desorption and steam passivation of organic-contaminated combustible residues would remove volatile organic contaminants from the residues and converts any plutonium fines present to plutonium oxide. The residues consist of materials such as wet and dry combustibles and leaded rubber gloves, some of which are above the safeguards termination limit for combustibles. The application of a variance to the safeguards termination limit would allow shipment of this material to WIPP for disposal as transuranic waste. This process would be conducted in Room 3701 of Building 371.

The process steps would include drum unloading and bag-in, feed preparation, followed by thermal desorption and steam passivation, addition of absorbent, packaging and bag-out, nondestructive assay, and drum transfer to interim site storage.

The description of the combination process for the thermal desorption and steam passivation of organic-contaminated combustibles is identical to that given in Section C.4.4, Thermal Desorption and Steam Passivation of Organic-Contaminated Combustibles.

C.7.9 Combination Process for the Repackaging of Dry Combustibles

The materials in the dry combustible residues category have received a variance to the safeguards termination limit. The processing of these residues is addressed in this technology description.

Under the combination concept for the repackaging of dry combustibles, repackaging of dry combustibles would be performed to achieve the criteria for safe interim site storage. Dry combustible residues consist of such materials as paper, rags, cloth, plastic, wood, surgical gloves, tape, paper, coveralls, booties, personal protective equipment waste, full-face masks, v-belts, polyvinyl chloride, polyethylene, polypropylene, supplied-air suits, and gaskets. After repackaging, the combustible residues above the safeguards termination limit will remain above the limit. The application of a variance to the safeguards termination limit would allow shipment of this material to WIPP for disposal as transuranic waste. Preparation of direct repackage residues would be conducted within glovebox lines in Modules D, E and F of Building 707.

The process steps include drum unloading and bag-in, feed preparation, repackaging and bag-out, nondestructive assay, and drum transfer to interim site storage.

The description of the combination process for the repackaging of dry combustibles is identical to that given in Section C.4.5, Repackaging of Dry Combustibles.

C.7.10 Combination Process for the Neutralization and Drying of Filter Media

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the filter media category have received a variance to the safeguards termination limit. The filter media residues with this variance that require neutralization are addressed in this technology description.

The filter media residues with a variance to the safeguards termination limit that require neutralization include Ful Flo filters and certain high-efficiency particulate air filters. The combination process for the neutralization and drying of filter media treats the nitric acid contaminant on the residue to eliminate the potential flammable hazard. After drying and repackaging, these residues would remain above the safeguards termination limit, which would preclude shipment to WIPP without the variance. This process would be conducted in Room 3701, Building 371.

The process steps would include drum unloading and bag-in, feed preparation, naturalization, decanting, and filtration, oven drying, packaging and bag-out, nondestructive assay, and drum transfer to interim site storage.

The description of the combination process for the neutralization and drying of filter media is identical to that given in Section C.4.7, Neutralization and Drying of Filter Media Residues.

C.7.11 Combination Process for the Repackaging of Filter Media

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the filter media category have received a variance to the safeguards termination limit. The filter media residues with these variances that do not require acid neutralization are addressed in this technology description.

The filter media residues with a variance to the safeguards termination limit that do not require acid neutralization include all filter media except for Ful Flo filters and IDC 338 high-efficiency particulate air filters. Under the combination concept for the repackaging of filter media, the filter media would be hand-blended to no more than 10 percent plutonium and repacked into 208-liter (55-gallon) drums for shipment to WIPP. The repack process would be conducted inside gloveboxes located in Room 3701, Building 371.

The combination process for the repackaging of filter media is shown in **Figure C-36.** The process steps would include drum unloading and bag in, feed preparation, repackaging (including blending), and bag-out. The packaged material would be placed into 208-liter (55-gallon) drums, non-destructively assayed for accountability purposes, and then would be ready for shipment to WIPP.

C.7.12 Combination Process for the Filtration and Drying of Sludge Residues

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the sludge category have received a variance to the safeguards termination limit. The sludge residues with this variance are addressed in this process description.

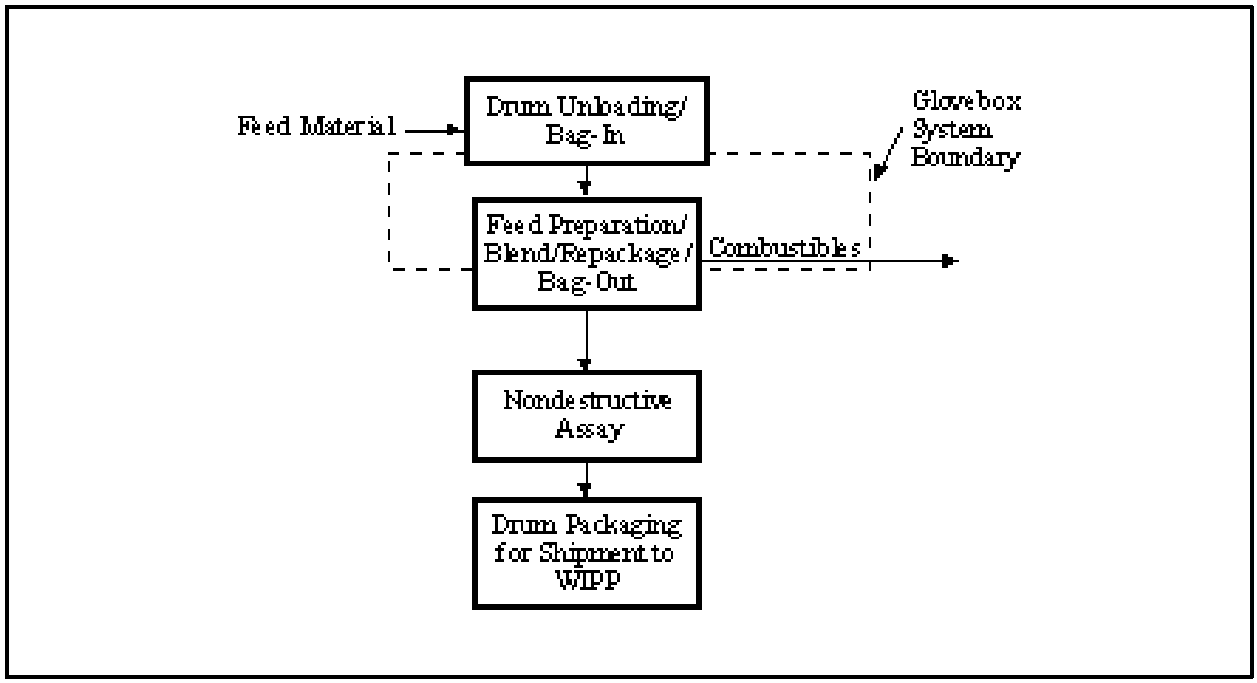


Figure C–36 Combination Process for the Repackaging of Filter Media

In the combination process for the filtration and drying of sludge residues, sludges would be filtered, if necessary, to remove excess liquid, and then dried by mixing the remaining material with an absorbent. After drying and repackaging, the sludges would remain above the safeguards termination limit, which would

preclude ultimate shipment to WIPP without the safeguard termination limit variance. This process would be conducted in Room 3701, Building 371.

The process steps would include drum unloading and bag-in, feed preparation, decanting, and filtration, absorbent addition and bag-out, nondestructive assay, and drum packaging for interim site storage.

The description of the combination process for the filtration and drying of sludge residues is identical to that given in Section C.4.8, Filtration and Drying of Sludge Residues.

C.7.13 Combination Process for the Repackaging of Sludge Residues

The residues in the EIS are divided into categories based upon similar applicable process technologies. The residues in the sludge category have received a variance to the safeguards termination limit. The sludge residues with this variance that do not require filtration and drying are addressed in this technology description.

The sludge residues with a variance to the safeguards termination limit that do not require filtration and drying include grease oxide, grease fluoride, and oily sludge. Under the combination concept for the repackaging of sludge residues, the sludges would be hand-blended to no more than 10 percent plutonium and repacked into 208-liter (55-gallon) drums for shipment to WIPP. The repack process would be conducted inside gloveboxes located in Room 3701, Building 371.

The combination process for the repackaging of sludge residues is shown in **Figure C-37.** The process steps would include drum unloading and bag-in, feed preparation, repackaging (including blending), and bag-out. The packaged material would be placed into 55-gallon drums, non-destructively assayed for accountability purposes, and then would be ready for shipment to WIPP.

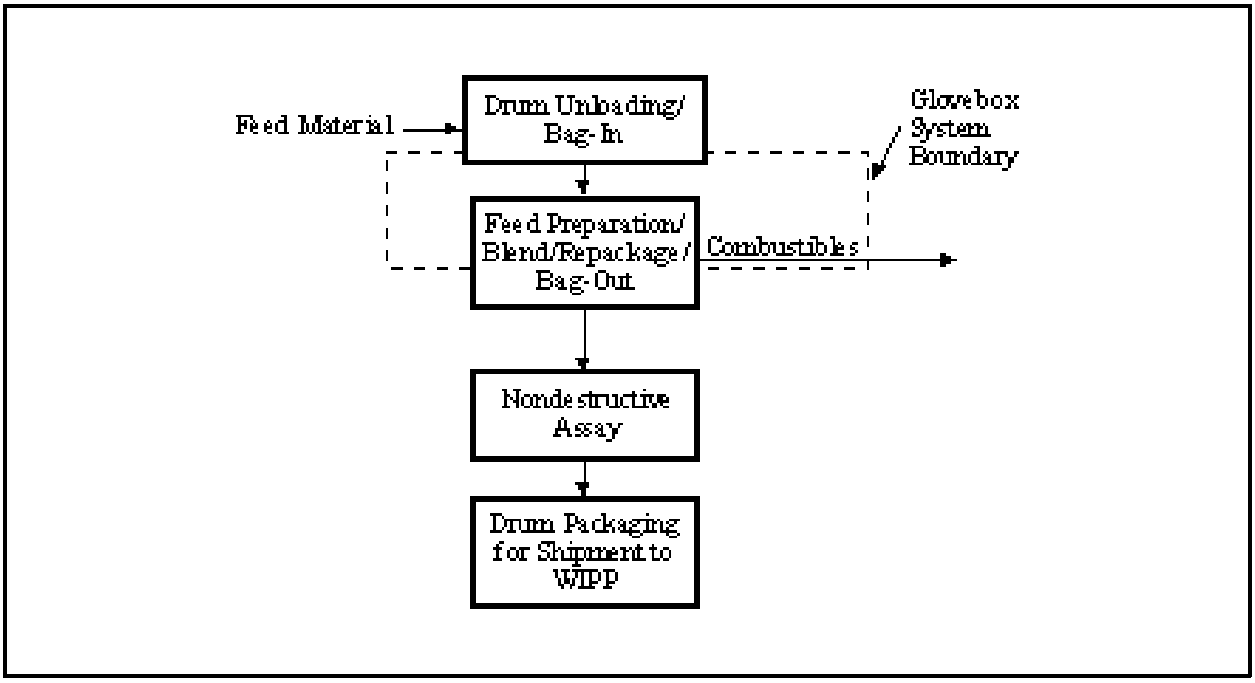


Figure C–37 Combination Process for the Repackaging of Sludge Residues

C.7.14 Combination Process for the Neutralization and Drying of Glass Residues

The materials in the glass residues category have received a variance to the safeguards termination limit. The processing of these residues is addressed in this technology description.

The combination process for the neutralization and drying of glass residues would remove the nitric acid contaminant on the residues eliminating a possibly unstable condition. The process would consist of washing the materials in an alkaline solution, allowing them to drain or partially dry, and mixing the resulting solids with water-absorbing materials. After processing, the glass residues may remain above the safeguards termination limit. The application of a variance to the safeguards termination limit would allow the shipment of this material to WIPP for disposal as transuranic waste. The process would be conducted in Room 3701 of Building 371.

The process steps would include drum unloading and bag-in, feed preparation, neutralization and decant/filtration, oven drying, blending, if necessary, packaging and bag-out, nondestructive assay, and drum transfer to interim site storage.

The description of the combination process for the neutralization and drying of glass residues is identical to that given in Section C.4.9, Neutralization and Drying of Glass Residues.

C.7.15 Combination Process for the Repackaging of Graphite Residues and Inorganic Residues

The materials in the graphite residue and inorganic residue categories have received a variance to the safeguards termination limit. The processing of these residues is addressed in this technology description.

Under the combination concept for the repackaging of graphite and inorganic residues, the graphite and inorganic residues would be repackaged to achieve the criteria for safe interim site storage. After repackaging, the residues may remain above the safeguards termination limit. The application of a variance to the safeguards termination limit would allow the shipment of this material to WIPP for disposal as transuranic waste. The process would be conducted within glovebox lines in Modules D, E and F of Building 707.

The process steps would include drum unloading and bag-in, feed preparation, blending, if necessary, repackaging and bag-out, nondestructive assay, and drum transfer to interim site storage.

The description of the combination process for the repackaging of graphite residues and inorganic residues is identical to that given in Section C.4.10, Repackaging of Graphite Residues, Inorganic Residues, and Scrub Alloy.

C.8 REFERENCES

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APPENDIX D
EVALUATION OF HUMAN HEALTH EFFECTS FROM ROUTINE PROCESSING/STORAGE OPERATIONS AND ACCIDENTS

This appendix presents detailed information on the potential impacts and risks to humans associated with releases of radioactivity and hazardous chemicals from the proposed processing and storage technologies during normal operations and from postulated accidents. This information is intended to support the public and occupational health and safety assessments described in Chapter 4 of this Environmental Impact Statement (EIS). Section D.1 provides general background information on radiation and associated health effects, as well as methods and general assumptions used in the assessment of normal and accident radiological impacts; Section D.2 provides information on releases associated with normal operational activities, as well as ranges of potential radiological impacts associated with these normal operational activities at each site; Section D.3 provides indepth information on postulated accidents; and Section D.4 provides information on hazardous chemical impacts. Information regarding potential radiological impacts resulting from intersite transportation is presented in Appendix E of this EIS.

This appendix presents numerical information using engineering and/or scientific notation. For example, the number 100,000 can also be expressed as 1×10^{5}. The fraction 0.00001 can also be expressed as 1×10^{-5}. The following chart defines the equivalent numerical notations that may be used in this appendix.

FRACTIONS AND MULTIPLES OF UNITS

Multiple	*Decimal Equivalent*	*Prefix*	*Symbol*
1×10^{6}	1,000,000	mega-	M
1×10^{3}	1,000	kilo-	k
1×10^{2}	100	hecto-	h
1×10	10	deka-	da
1×10^{-1}	0.1	deci-	d
1×10^{-2}	0.01	centi-	c
1×10^{-3}	0.001	milli-	m
1×10^{-6}	0.000001	micro-	μ
1×10^{-9}	0.000000001	nano-	n
1×10^{-12}	0.000000000001	pico-	p
1×10^{-15}	0.000000000000001	femto-	f
1×10^{-18}	0.000000000000000001	atto-	a

D.1 RADIOLOGICAL IMPACTS TO HUMAN HEALTH

This section presents supporting information on the potential radiological impacts to humans from normal operations and postulated accidents. It provides the reader with background information on the nature of radiation (Section D.1.1), the methodology used to calculate radiological impacts (Section D.1.2), the input data for the various processing assessments at each site (Section D.1.3), and sample process flow diagrams/ tables that are coordinated with the discussions presented in Appendix C (Section D.1.4).

D.1.1 Background

D.1.1.1 Nature of Radiation and Its Effects on Humans

❒ **What Is Radiation?—**Radiation is energy transferred in the form of particles or waves. Humans are exposed constantly to radiation from the solar system and from the earth's rocks and soil. This radiation contributes to the natural background radiation that has always surrounded us. Manmade sources of radiation also exist, including medical and dental x-rays, household smoke detectors, and materials released from nuclear and coal-fired power plants.

Radiation comes from the activity of atoms, which form the substance of all matter in the universe. Atoms are composed of even smaller particles (protons, neutrons, electrons), whose number and arrangement distinguish one atom from another. Atoms of different types are known as elements. There are more than 100 natural and manmade elements. Some of these elements, such as uranium, radium, plutonium, and thorium, share a very important quality: they are unstable (i.e., they decay). As they change into more stable forms, invisible waves of energy or particles, known as ionizing radiation, are released. Radioactivity is the emitting of this radiation.

Ionizing radiation refers to the fact that this energy force can ionize, or electrically charge, atoms by stripping off electrons. Ionizing radiation can cause a change in the chemical composition of many things, including living tissue (organs), which can affect the way they function.

- Alpha (á) particles are the heaviest type of ionizing radiation; despite a speed of approximately 16,000 kilometers/second (km/sec) (9,940 miles [mi]/sec), they can travel only several centimeters in air. Alpha particles lose their energy almost as soon as they collide with anything. They can be stopped easily by a sheet of paper or by the skin's surface.

Radiation Type	Typical Speed km/sec	Typical Travel Distance in Air (m)	Barrier
α	16,000	< 1	Sheet of paper or skin's surface
β	160,000	3	Thin sheet of aluminum foil or glass
γ	300,000	Very Large [a]	Thick wall of concrete, lead, or steel
n	39,000	Very Large	Water, Paraffin, Graphite

[a] *Would be infinite in a vacuum*

- Beta particles (â) are much lighter than alpha particles. They can travel at a speed up to 160,000 km/sec (99,400 mi/sec) and can travel in the air for a distance of approximately 3 meters (m) (9.8 feet [ft]). Beta particles can pass through a sheet of paper but may be stopped by a thin sheet of aluminum foil or glass.

- Gamma rays (ã) and x-rays, unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light (300,000 km/sec [186,000 mi/sec]). Gamma radiation is very penetrating and requires a thick wall of concrete, lead, or steel to stop it.

- The neutron (n) is another particle that contributes to radiation exposure, both directly and indirectly. The latter is associated with the gamma rays and alpha particles that are emitted following neutron capture in matter. A neutron has about one quarter the weight of an alpha particle and can travel at speeds of up to 39,000 km/sec (24,200 mi/sec). Neutrons are more penetrating than beta particles but less penetrating than gamma rays.

The effects on people of radiation emitted during the disintegration (decay) of a radioactive substance depend on the type of radiation (alpha and beta particles and gamma and x-rays) and the total amount of radiation energy absorbed by the body. The total energy absorbed per unit quantity of tissue is referred to as absorbed dose. The absorbed dose, when multiplied by certain quality factors and factors that take into account different sensitivities of various tissues, is referred to as effective dose equivalent or, where the context is clear, simply dose. The common unit of effective dose equivalent is the roentgen equivalent man (rem); 1 rem equals 1,000 millirem (mrem).

The radioactivity of an isotope decreases with time. The time it takes an isotope to lose half of its original radioactivity is designated its half-life. For example, a quantity of iodine-131, an isotope that has a half-life of 8 days, will lose one-half of its radioactivity in that amount of time. In 8 more days, one-half of the remaining radioactivity will be lost, and so on. Eventually, the radioactivity will essentially disappear. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements may vary from millionths of a second to millions of years.

When a radioactive element emits a particle or gamma-ray, it often changes to an entirely different element, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation, which may take several steps, is known as a decay chain. Radium, for example, is a naturally occurring radioactive element with a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays first to polonium, then through a series of steps to bismuth, and ultimately to lead.

❒ **Units of Radiation Measure—**Scientists and engineers use a variety of units to measure radiation. These different units can be used to determine the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or effects using units of calories or degrees, amounts of radiation can be measured in curies (Ci), radiation absorbed dose (rad), or rem.

- *Curie*—The curie, named after the French scientists Marie and Pierre Curie, describes the "intensity" of a sample of radioactive material. The rate of decay of 1 gram (g) of radium is the basis of this unit of measure. It is equal to 3.7×10^{10} disintegrations (decays)/sec.

- *Rad*—The total energy absorbed per unit quantity of tissue is referred to as absorbed dose. The rad is the unit of measurement for the physical absorption of radiation. As sunlight heats pavement by giving up an amount of energy to it, so radiation gives up rads of energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

Radiation Units and Conversions

1 Ci = 3.7×10^{10} sec^{-1} = 3.7×10^{10} Becquerel
1 rad = 100 erg/g = 0.01 Gray
1 erg = 10^{-7} joule
1 Gray = 1 joule/kg = 100 rad
1 rem = 0.01 Sievert

- *Rem*—A rem is a measurement of the dose from radiation based on its biological effects. The rem is used in measuring the effects of radiation on the body as degrees Centigrade are used in measuring the effects of sunlight heating pavement. Thus, 1 rem of one

type of radiation is presumed to have the same biological effects as 1 rem of any other kind of radiation. This allows comparison of the biological effects of radionuclides that emit different types of radiation.

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). The external dose is different from the internal dose because an external dose is delivered only during the actual time of exposure to the external radiation source, but an internal dose continues to be delivered as long as the radioactive source is in the body. For the analyses conducted in this EIS, the dose from internal exposure is calculated over 50 years following the initial exposure; both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time.

The three types of doses calculated in this EIS are external dose, internal dose, and combined external and internal dose. Each type of dose is discussed separately in the following paragraphs:

- *External Dose*—The external dose can result from several different pathways, all having in common the fact that the radiation causing the exposure is external to the body. In this EIS, these pathways include exposure to a cloud of radiation passing over the receptor, standing on ground that is contaminated with radioactivity, swimming in contaminated water, and boating in contaminated water. The appropriate measure of dose is called the effective dose equivalent. If the receptor departs from the source of radiation exposure, the dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year.

- *Internal Dose*—The internal dose results from a radiation source entering the human body through either ingestion of contaminated food and water or inhalation of contaminated air. In this EIS, pathways for internal exposure include: (1) ingestion of crops contaminated either by airborne radiation deposits or by irrigation using contaminated water sources, (2) ingestion of animal products from animals that ingested contaminated food, (3) ingestion of contaminated water, and (4) inhalation of contaminated air. In contrast to external exposure, once radiation from internal exposure enters the body, it remains there for a period of time that varies depending on decay and biological elimination rates. The unit of measure for internal doses is the committed dose equivalent. It is the internal dose that each body organ receives from 1 "year intake" (ingestion plus inhalation). Normally, a 50- or 70-year dose-commitment period is used (i.e., the 1-year intake period plus 49 or 69 years). The dose rate increases during the 1 year intake. The dose rate after the first year intake declines slowly as the radioactivity in the body continues to produce a dose. The integral of the dose rate over the 50 or 70 years gives the committed dose equivalent. In this EIS, a 50-year dose-commitment period was used.

  The various organs of the body have different susceptibilities to harm from radiation. The quantity that takes these different susceptibilities into account to provide a broad indicator of the risk to the health of an individual from radiation is called the committed effective dose equivalent. It is obtained by multiplying the committed dose equivalent in each major organ or tissue by a weighting factor associated with the risk susceptibility of the tissue or organ, then summing the totals. It is possible for the committed dose equivalent to an organ to be larger than the committed effective dose equivalent if that organ has a small weighting factor. The concept of committed effective dose equivalent applies only to internal pathways.

- *Combined External and Internal Dose*—For convenience, the sum of the committed effective dose equivalent from internal pathways and the effective dose equivalent from external pathways is also called the committed effective dose equivalent in this EIS. The U.S. Department of Energy (DOE), in DOE Order 5400.1, calls this quantity the effective dose equivalent (DOE 1990).

The units used in this EIS for committed dose equivalent, effective dose equivalent, and committed effective dose equivalent to an individual are the rem and mrem (1/1000 of 1 rem). The corresponding unit for the collective dose to a population (the sum of the doses to members of the population, or the product of the number of exposed individuals and their average dose) is the person-rem.

❒ **Sources of Radiation—**The average American receives a total of approximately 350 mrem/year (yr) from all sources of radiation, both natural and manmade. The sources of radiation can be divided into six different categories: (1) cosmic radiation, (2) terrestrial radiation, (3) internal radiation, (4) consumer products, (5) medical diagnosis and therapy, and (6) other sources (NCRP 1987). These categories are discussed in the following paragraphs:

- *Cosmic Radiation*—Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the earth's atmosphere. These particles, and the secondary particles and photons they create, are cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with altitude above sea level. For the sites considered in this EIS, the cosmic radiation ranges from 27 to 51 mrem/yr. The average dose to the people in the United States is approximately 27 mrem/yr.

- *External Terrestrial Radiation*—External terrestrial radiation is the radiation emitted from the radioactive materials in the earth's rocks and soils. The external terrestrial radiation for the sites in this EIS ranges from 28 to 63 mrem/yr. The average dose from external terrestrial radiation is approximately 28 mrem/yr.

- *Internal Radiation*—Internal radiation results from the human body metabolizing natural radioactive material that has entered the body by inhalation or ingestion. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributor to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon, which contribute approximately 200 mrem/yr. The average dose from other internal radionuclides is approximately 39 mrem/yr.

- *Consumer Products*—Consumer products also contain sources of ionizing radiation. In some products, such as smoke detectors and airport x-ray machines, the radiation source is essential to the products' operation. In other products, such as televisions and tobacco, the radiation occurs incidentally to the product function. The average dose from consumer products is approximately 10 mrem/yr.

- *Medical Diagnosis and Therapy*—Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x-rays result in an average exposure of 39 mrem/yr. Nuclear medical procedures result in an average exposure of 14 mrem/yr.

- *Other Sources*—There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel-cycle facilities (e.g., uranium mines, mills, and fuel processing plants), nuclear power plants, and transportation routes has been estimated to be less than 1 mrem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions of radioactive material from DOE and Nuclear Regulatory Commission licensed facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials contribute less than 1 mrem/yr to the average dose to an individual. Air travel contributes approximately 1 mrem/yr to the average dose.

The collective (or population) dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. This total dose received by the exposed population is measured in person-rem. For example, if 1,000 people each receive a dose of 1 mrem (0.001 rem), the

collective dose is 1,000 persons × 0.001 rem = 1.0 person-rem. Alternatively, the same collective dose (1.0 person-rem) results if 500 people each receive a dose of 2 mrem (500 persons × 2 mrem = 1 person-rem).

- **Limits of Radiation Exposure—**The amount of manmade radiation that the public may be exposed to is limited by Federal regulations. Although most scientists believe that radiation absorbed in small doses over several years is not harmful, U.S. Government regulations assume that the effects of all radiation exposures are cumulative.

  Under the Clean Air Act, the exposure to a member of the general public from DOE facility releases into the atmosphere is limited by the U.S. Environmental Protection Agency (EPA) to a dose of 10 mrem/yr in addition to the natural background and medical radiation normally received (EPA 1995a). DOE also limits to 10 mrem the dose annually received from material released to the atmosphere (DOE 1993e). EPA and DOE also limit the annual dose to a member of the general public from radioactive releases to drinking water to 4 mrem, as required under the Safe Drinking Water Act (EPA 1992a; DOE 1993e). The DOE annual limit of radiation dose from all pathways to a member of the general public is 100 mrem. (DOE 1993e).

  Each of the three sites covered by this EIS operates below all of these limits. The average individual in the United States receives a dose of approximately 0.3 rem (300 mrem) per year from natural sources of radiation. For perspective, a modern chest x-ray results in an approximate dose of 0.006 rem (6 mrem) and a diagnostic pelvis and hip x-ray results in an approximate dose of 0.065 rem (65 mrem) (NCRP 1987). An acute dose of about 450 rem (450,000 mrem) would result in a 50 percent chance of death.

  For people working in an occupation that involves radiation, the Nuclear Regulatory Commission and DOE limit doses to 5 rem (5,000 mrem) in any 1 year (NRC 1993; DOE 1993a). DOE also conventionally imposes a 2 rem/yr Administrative Control Limit amongst its sites in the interest of complying with As Low As Reasonably Achievable initiatives (DOE 1996a).

D.1.1.2 Health Effects

Radiation exposure and its consequences are topics of interest to the general public. For this reason, this EIS places much emphasis on the consequences of exposure to radiation, even though the effects of radiation exposure under most circumstances evaluated in this EIS are small. To provide the background for discussions of impacts, this section explains the basic concepts used in the evaluation of radiation effects.

Radiation can cause a variety of ill-health effects in people. The most significant ill-health effect to depict the consequences of environmental and occupational radiation exposure is induction of cancer fatalities. This effect is referred to as "latent" cancer fatalities because the cancer may take many years to develop and for death to occur and may not actually be the cause of death. In the discussions that follow, all fatal cancers are considered latent and the term "latent" is not used.

Health impacts from radiation exposure, whether from sources external or internal to the body, generally are identified as "somatic" (affecting the individual exposed) or "genetic" (affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects than to produce genetic effects. For this EIS, therefore, only the somatic risks are presented. The somatic risks of most importance are the induction of cancers. Except for leukemia, which can have an induction period (time between exposure to carcinogen and cancer diagnosis) of as little as 2 to 7 years, most cancers have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. Such cancers, however, also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because of the readily available data for cancer mortality rates and the relative scarcity of prospective epidemiologic studies, somatic effects leading to cancer fatalities rather than cancer incidence are presented in this EIS. The numbers of cancer fatalities can be used to compare the risks among the various alternatives.

The National Research Council's Committee on the Biological Effects of Ionizing Radiation has prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposures. The latest of these reports, *Health Effects of Exposure to Low Levels of Ionizing Radiation BEIR V* (NAS 1990), provides the most current estimates for excess mortality from leukemia and cancers other than leukemia expected to result from exposure to ionizing radiation. This report updates the models and risk estimates provided in an earlier report of the Committee, *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*. The BEIR V models were developed for application to the U.S. population.

BEIR V provides estimates that are consistently higher than those in its predecessor BEIR III. This increase is attributed to several factors, including the use of a linear dose response model for cancers other than leukemia, revised dosimetry for the Japanese atomic bomb survivors, and additional follow-up studies of the atomic bomb survivors and other cohorts. BEIR III employs constant relative and absolute risk models, with separate coefficients for each of several sex and age-at-exposure groups; BEIR V develops models in which the excess relative risk is expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. The BEIR III models were based on the assumption that absolute risks are comparable between the atomic bomb survivors and the U.S. population; BEIR V models were based on the assumption that the relative risks are comparable. For a disease such as lung cancer, where baseline risks in the United States are much larger than those in Japan, the BEIR V approach leads to larger risk estimates than the BEIR III approach.

The models and risk coefficients in BEIR V were derived through analyses of relevant epidemiologic data that included the Japanese atomic bomb survivors, ankylosis spondylitis patients, Canadian and Massachusetts fluoroscopy patients (breast cancer), New York postpartum mastitis patients (breast cancer), Israel Tinea Capitis patients (thyroid cancer), and Rochester thymus patients (thyroid cancer). Models for leukemia, respiratory cancer, digestive cancer, and other cancers used only the atomic bomb survivor data, although results of analyses of the ankylosis spondylitis patients were considered. Atomic bomb survivor analyses were based on revised dosimetry with an assumed relative biological effectiveness of 20 for neutrons and were restricted to doses less than 400 rads. Estimates of risks of fatal cancers other than leukemia were obtained by totaling the estimates for breast cancer, respiratory cancer, digestive cancer, and other cancers.

- **Risk Estimates for Doses Equal to or Greater than 20 Rem—**BEIR V includes risk estimates for a single exposure to a high level of radiation to all people in a large population group. The estimates are given in terms of lifetime risks per 1.0×10^{6} person-rem. Fatality estimates for leukemia, breast cancer, respiratory cancer, digestive cancer, and other cancers are given for both sexes and nine age-at-exposure groups. These estimates, based on the linear model, are summarized in **Table D–1**. The average risk estimate from all ages and both sexes is 885 excess cancer fatalities per million person-rem. This value has been conservatively rounded up to 1,000 excess cancer fatalities per million person-rem.

Table D–1 Lifetime Risks per 100,000 Persons Exposed to a Single Exposure of 10 Rem[a]

Gender	*Type of Fatal Cancer*		
	Leukemia [b]	*Cancers Other Than Leukemia*	*Total Cancers*
Male	220	660	880
Female	160	730	890
Average	190	695	885[c]

[a] The risk values in this table are applied to situations in which the dose received by an individual is greater than 10 rem per hour. The accident analyses in this EIS assumes that the rate of exposure is greater than this value if the dose received during the accident is greater than 20 rem. For those accidents, the risk values in Table D-1 are applied.

[b] These are the linear estimates, which are double the linear-quadratic estimates provided in BEIR V for leukemia at low doses and dose-rates.

[c] This value has been rounded up to 1,000 excess cancer fatalities per million person-rem.

Source: NAS 1990.

Although values for other health effects are not presented in this EIS, the risk estimators for nonfatal cancers and for genetic disorders to future generations are estimated to be approximately 200 and 260 per million person-rem, respectively. These values are based on information presented in the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991) and are seen to be 20 percent and 26 percent, respectively, of the fatal cancer estimator. Thus, if the number of excess fatal cancers is projected to be "X," the number of excess genetic disorders would be 0.26 times "X."

❒ **Risk Estimates for Doses Less than 20 Rem—**For doses lower than 20 rem, a linear-quadratic model provides a significantly better fit to the data for leukemia than a linear model, and leukemia risks were based on a linear-quadratic function, which reduces the effects by a factor of two over estimates that are obtained from a linear model. For other cancers, linear models were found to provide an adequate fit to the data and were used for extrapolation to low doses. The BEIR V Committee, however, recommended reducing these linear estimates by a factor between 2 and 10 for doses received at low dose rates. For this EIS, a risk reduction factor of two was adopted for conservatism.

Based on the preceding discussion, the resulting risk estimator would be equal to half the value observed for high-dose situations or approximately 500 excess fatal cancers per million person-rem (0.0005 excess fatal cancer per person-rem). This is the risk value used in this EIS to calculate fatal cancers to the general public during normal operations and also for accidents in which individual doses are less than 20 rem. For workers, a value of 400 excess fatal cancers per million person-rem (0.0004 excess fatal cancer per person-rem) is used in this EIS. This lower value reflects the absence of children (who are more radiosensitive than adults) in the workforce. Again, based on information provided in the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991), the health risk estimators for nonfatal cancer and genetic disorders among the public are 20 percent and 26 percent, respectively, of the fatal cancer risk estimator. For workers, the health risk estimators are both 20 percent of the fatal cancer risk estimator. For this EIS, only fatal cancers are presented.

The risk estimates may be applied to calculate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to natural background radiation (0.3 rem/yr), 15 latent cancer fatalities per year would result from this radiation (100,000 persons × 0.3 rem/yr × 0.0005 latent cancer fatalities per person-rem = 15 latent cancer fatalities/yr).

Calculations of the number of excess cancer fatalities associated with radiation exposure do not always yield whole numbers; calculations may yield numbers less than 1.0, especially in environmental applications. For example, if a population of 100,000 were exposed as described in the previous paragraph but to a total dose of only 0.001 rem, the collective dose would be 100 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.05 (100,000 persons × 0.001 rem × 0.0005 latent cancer fatalities/person-rem = 0.05 latent cancer fatalities).

For latent cancer fatalities less than 1.0, the estimated 0.05 latent cancer fatalities is a statistical estimate—0.05 is the *average* number of deaths that would result if the same exposure situation were

applied to many different groups of 100,000 people. In most groups, no person (0 people) would incur a latent cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, 1 latent cancer fatality would result; in exceptionally few groups, 2 or more latent cancer fatalities would occur. The *average* number of deaths over all the groups would be 0.05 latent cancer fatalities (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is 0 latent cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to background radiation over a lifetime. The "number of latent cancer fatalities" corresponding to a single individual's exposure over a (presumed) 72-year lifetime to 0.3 rem/yr is the following:

1 person × 0.3 rem/yr × 72 yr × 0.0005 latent cancer fatalities/person-rem = 0.011 latent cancer fatalities.

Again, this is a statistical estimate; that is, the estimated effect of background radiation exposure on the exposed individual would produce a 1.1 percent chance that the individual might incur a latent cancer fatality caused by the exposure over his full lifetime. Presented another way, this method estimates that approximately 1.1 percent of the population might die of cancers induced by background radiation (DOE 1996a).

D.1.2 Methodology for Estimating Radiological Impacts

The radiological impacts of normal operations and postulated accidents of processing/storage facilities were calculated using Version 1.485 of the GENII computer code, which will remain the latest version of the code available until the 1998–1999 timeframe (PNNL 1997). Site-specific and technology-specific input data were used, including location, meteorology, population, food production and consumption, and source terms. Section D.1.2.1 briefly describes GENII and outlines the approach used for normal operations. The approach used for design basis accidents is discussed later in Section D.3.

D.1.2.1 GENII Computer Code

The GENII computer model, developed by Pacific Northwest Laboratory, is an integrated system of various computer modules that analyze environmental contamination resulting from acute or chronic releases to, or initial contamination in, air, water, or soil. The model calculates radiation doses to individuals and populations. The GENII computer model is well documented for assumptions, technical approach, methodology, and quality assurance issues (PNL 1988). The GENII computer model has gone through extensive quality assurance and quality control steps, including comparing results from model computations with those from hand calculations and performing internal and external peer reviews. Recommendations given in these reports were incorporated into the final GENII computer model, as deemed appropriate.

For this EIS, only the ENVIN, ENV, and DOSE computer modules were used. The codes are connected through data transfer files. The output of one code is stored in a file that can be used by the next code in the system.

- **ENVIN—**The ENVIN module of the GENII code controls the reading of input files and organizes the input for optimal use in the environmental transport and exposure module, ENV. The ENVIN code interprets the basic input, reads the basic GENII data libraries and other optional input files, and organizes the input into sequential segments based on radionuclide decay chains.

  A standardized file that contains scenario, control, and inventory parameters is used as input to ENVIN. Radionuclide inventories can be entered as functions of releases to air or water, concentrations in basic

environmental media (air, soil, or water), or concentrations in foods. If certain atmospheric dispersion options have been selected, this module can generate tables of atmospheric dispersion parameters that will be used in later calculations. If the finite plume air submersion option is requested in addition to the atmospheric dispersion calculations, preliminary energy-dependent finite plume dose factors are prepared as well. The ENVIN module prepares the data transfer files that are used as input by the ENV module; ENVIN generates the first portion of the calculation documentation—the run input parameters report.

- **ENV—**The ENV module calculates the environmental transfer, uptake, and human exposure to radionuclides that result from the chosen scenario for the user-specified source term. The code reads the input files from ENVIN and then, for each radionuclide chain, sequentially performs the precalculations to establish the conditions at the start of the exposure scenario. Environmental concentrations of radionuclides are established at the beginning of the scenario by assuming decay of preexisting sources, considering biotic transport of existing subsurface contamination, and defining soil contamination from continuing atmospheric or irrigation depositions. For each year of postulated exposure, the code then estimates the air, surface soil, deep soil, groundwater, and surface water concentrations of each radionuclide in the chain. Human exposures and intakes of each radionuclide are calculated for (1) pathways of external exposure from finite atmospheric plumes; (2) inhalation; (3) external exposure from contaminated soil, sediments, and water; (4) external exposure from special geometries; and (5) internal exposures from consumption of terrestrial foods, aquatic foods, drinking water, animal products, and inadvertent intake of soil. The intermediate information on annual media concentrations and intake rates are written to data transfer files. Although these may be accessed directly, they are usually used as input to the DOSE module of GENII.

- **DOSE—**The DOSE module reads the intake and exposure rates defined by the ENV module and converts the data to radiation dose.

D.1.2.2 Data and General Assumptions for Normal Operations and Postulated Accidents

To perform the dose assessments for this EIS, different types of data were collected and/or generated. In addition, calculational assumptions were made. This section discusses both the data collected and/or generated for use in performing the dose assessments and the assumptions made for this EIS.

- **Meteorological Data—**The meteorological data used for all sites discussed in this EIS were in the form of joint frequency data files. A joint frequency data file is a table listing the fractions of time the wind blows in a certain direction, at a certain speed, and within a certain stability class. The joint frequency data files were based on measurements taken over a period of several years at different locations and heights on each of the sites. Average annual meteorological conditions (averaged over the measurement period) were used for normal operations.

- **Population Data—**Population distributions were based on site-provided information and on the *1990 Census of Population and Housing* data (DOC 1992). Projections were determined for the year 2000 (approximate midlife of operations) for areas within 80 km (50 mi) of the proposed facilities at each candidate site. The site population in 2000, assumed to be representative of the population over the operational period evaluated, was used in the impact assessments. The population was spatially distributed on a circular grid with 16 directions and 10 radial distances up to 80 km (50 mi). The grid was centered on the facility from which the radionuclides were assumed to be released.

- **Source Term Data—**The source terms (quantities of radionuclides released to the environment over a given period) for each alternative were estimated based on experience with similar facility operations and

safety analysis assessments. The source terms used to generate the estimated impacts of normal operations are provided in Section D.2 for the processing/storage processes examined in this EIS.

❒ **Food Production and Consumption Data—**Data from the *1987* and *1992 Censuses of Agriculture* (DOC 1988; DOC 1993) were used to generate site-specific data for food production. Food production was spatially distributed on the same circular grid used for the population distributions. The consumption rates used in GENII were those for the maximum individual and average individual. People living within the 80-km (50-mi) assessment area were assumed to consume only food grown in that area.

❒ **Calculational Assumptions—**Dose assessments were performed for both members of the general public and workers for each site examined in this EIS. These assessments were made to determine the *incremental* doses that would be associated with the alternatives addressed in this EIS. Doses for members of the public were calculated for two different types of receptors: the maximally exposed offsite individual and the general population living within 80 km (50 mi) of the facility. The maximally exposed individual associated with the alternatives addressed in this EIS was assumed to be located at a position on the site boundary that would receive the highest dose during normal operations or during a postulated accident of a given alternative. Similarly, an 80-km (50-mi) population dose was calculated for each operating processing/storage facility at the sites.

To estimate the radiological impacts from incident-free (normal) operations of processing/storage facilities, the following additional assumptions and factors were considered in using GENII:

- Ground surfaces were assumed to have no previous deposition of radionuclides.
- The annual external exposure time to the plume and to soil contamination was 0.7 year for the maximally exposed offsite individual (NRC 1977).
- The annual external exposure time to the plume and to soil contamination was 0.5 year for the population (NRC 1977).
- The annual inhalation exposure time to the plume was 1.0 year for the maximally exposed individual and general population (NRC 1977).
- The exposed individual or population was assumed to have the characteristics and habits (e.g., inhalation and ingestion rates) of the adult human.
- A semi-infinite/finite plume model was used for air immersion doses. Other pathways evaluated were ground exposure, inhalation, ingestion of food crops, and ingestion of contaminated animal products. Drinking water, aquatic food ingestion, and any other pathways that may involve liquid exposure are not examined because all releases are to the air.
- Reported stack heights were used for atmospheric releases. The resultant doses were conservative, as use of the actual stack height instead of the effective stack height negates plume rise.
- The calculated doses were 50-year committed doses from 1 year of intake.

To estimate the radiological impacts from postulated accident scenarios, the following assumptions and factors were considered in using GENII (an extensive discussion of these assumptions is presented in Section D.3.3.1):

- Ground surfaces were assumed to have no previous deposition of radionuclides.
- The external exposure time to soil contamination was 0.7 year for the maximally exposed offsite individual and the general population.
- The exposed individual or population was assumed to have the characteristics and habits (e.g., inhalation and ingestion rates) of the adult human.
- Drinking water, aquatic food ingestion, and any other pathways that may involve liquid exposure are not examined because all releases are to the air.
- A semi-infinite plume model was used for air immersion doses.
- Reported stack heights were used for atmospheric releases and were assumed to be the effective stack height. The resultant doses were conservative, as use of the actual stack height negates plume rise.

The exposure, uptake, and usage parameters used in the GENII model for normal operations are provided in **Table D–2** through **Table D–4**. The parameters used for postulated accidents are presented in **Table D–5** through **Table D–7**.

Table D–2 GENII Exposure Parameters to Plumes and Soil Contamination (Normal Operations)

Maximum Individual				*General Population*			
External Exposure		*Inhalation of Plume*		*External Exposure*		*Inhalation of Plume*	
Plume (hours)	*Soil Contamination (hours)*	*Exposure Time (hours)*	*Breathing Rate (cm^3/sec)*	*Plume (hours)*	*Soil Contamination (hours)*	*Exposure Time (hours)*	*Breathing Rate (cm^3/sec)*
6,136	6,136	8,766	270	4,383	4,383	8,766	270

cm^3/sec = cubic centimeter per second
Source: PNL 1988, NRC 1977.

Table D–3 GENII Usage Parameters for Consumption of Terrestrial Food (Normal Operations)

	Maximum Individual				*General Population*			
Food Type	*Growing Time (days)*	*Yield (kg/m^2)*	*Holdup Time (days)*	*Consumption Rate (kg/yr)*	*Growing Time (days)*	*Yield (kg/m^2)*	*Holdup Time (days)*	*Consumption Rate (kg/yr)*
Leafy Vegetables	90.0	1.5	1.0	30.0	90.0	1.5	14.0	15.0
Root Vegetables	90.0	4.0	5.0	220.0	90.0	4.0	14.0	140.0
Fruit	90.0	2.0	5.0	330.0	90.0	2.0	14.0	64.0
Grains/Cereals	90.0	0.8	180.0	80.0	90.0	0.8	180.0	72.0

kg/m^2 = kilogram per square meter kg/yr = kilogram per year
Source: PNL 1988.

Table D–4 GENII Usage Parameters for Consumption of Animal Products (Normal Operations)

			Stored Feed				*Fresh Forage*			
Food Type	*Consumption Rate (kg/yr)*	*Holdup Time (days)*	*Diet Fraction*	*Growing Time (days)*	*Yield (kg/m^2)*	*Storage Time (days)*	*Diet Fraction*	*Growing Time (days)*	*Yield (kg/m^2)*	*Storage Time (days)*

Maximum Individual										
Beef	80.0	15.0	0.25	90.0	0.80	180.0	0.75	45.0	2.00	100.0
Poultry	18.0	1.0	1.00	90.0	0.80	180.0	--	--	--	--
Milk	270.0	1.0	0.25	45.0	2.00	100.0	0.75	30.0	1.50	0.00
Eggs	30.0	1.0	1.00	90.0	0.80	180.0	--	--	--	--
General Population										
Beef	70.0	34.0	0.25	90.0	0.80	180.0	0.75	45.0	2.00	100.0
Poultry	8.5	34.0	1.0	90.0	0.80	180.0	--	--	--	--
Milk	230.0	3.0	0.25	45.0	2.00	100.0	0.75	30.0	1.50	0.00
Eggs	20.0	18.0	1.0	90.0	0.80	180.0	--	--	--	--

kg/yr = kilogram per year kg/m^2 = kilogram per square meter
Source: PNL 1988.

Table D–5 GENII Exposure Parameters to Plumes and Soil Contamination (Postulated Accidents)

Maximum Individual				***General Population***			
External Exposure		***Inhalation of Plume***		***External Exposure***		***Inhalation of Plume***	
Plume (hours)	***Soil Contamination (hours)***	***Exposure Time (hours)***	***Breathing Rate (cm^3/sec)***	***Plume (hours)***	***Soil Contamination (hours)***	***Exposure Time (hours)***	***Breathing Rate (cm^3/sec)***
0.00	6,136	100% of Release Time	330	0.00	6,136	100% of Release Time	330

cm^3/sec = cubic centimeter per second
Source: PNL 1988, NRC 1977.

Table D–6 GENII Usage Parameters for Consumption of Terrestrial Food (Postulated Accidents)

	Maximum Individual				***General Population***			
Food Type	***Growing Time (days)***	***Yield (kg/m^2)***	***Holdup Time (days)***	***Consumption Rate (kg/yr)***	***Growing Time (days)***	***Yield (kg/m^2)***	***Holdup Time (days)***	***Consumption Rate (kg/yr)***
Leafy Vegetables	90.0	1.5	1.0	30.0	90.0	1.5	14.0	15.0
Root Vegetables	90.0	4.0	5.0	220.0	90.0	4.0	14.0	140.0
Fruit	90.0	2.0	5.0	330.0	90.0	2.0	14.0	64.0
Grains/Cereals	90.0	0.8	180.0	80.0	90.0	0.8	180.0	72.0

kg/m^2 = kilogram per square meter kg/yr = kilogram per year
Source: PNL 1988.

Table D–7 GENII Usage Parameters for Consumption of Animal Products (Postulated Accidents)

			Stored Feed				***Fresh Forage***			
Food Type	***Consumption Rate (kg/yr)***	***Holdup Time (days)***	***Diet Fraction***	***Growing Time (days)***	***Yield (kg/m^2)***	***Storage Time (days)***	***Diet Fraction***	***Growing Time (days)***	***Yield (kg/m^2)***	***Storage Time (days)***
Maximum Individual										
Beef	80.0	15.0	0.25	90.0	0.80	180.0	0.75	45.0	2.00	100.0
Poultry	18.0	1.0	1.00	90.0	0.80	180.0	--	--	--	--

Food Type	*Consumption Rate (kg/yr)*	*Holdup Time (days)*	*Stored Feed*				*Fresh Forage*			
			Diet Fraction	*Growing Time (days)*	*Yield (kg/m^2)*	*Storage Time (days)*	*Diet Fraction*	*Growing Time (days)*	*Yield (kg/m^2)*	*Storage Time (days)*
Milk	270.0	1.0	0.25	45.0	2.00	100.0	0.75	30.0	1.50	0.00
Eggs	30.0	1.0	1.00	90.0	0.80	180.0	--	--	--	--
General Population										
Beef	70.0	34.0	0.25	90.0	0.80	180.0	0.75	45.0	2.00	100.0
Poultry	8.5	34.0	1.0	90.0	0.80	180.0	--	--	--	--
Milk	230.0	3.0	0.25	45.0	2.00	100.0	0.75	30.0	1.50	0.00
Eggs	20.0	18.0	1.0	90.0	0.80	180.0	--	--	--	--

kg/yr = kilogram per year kg/m^2 = kilogram per square meter
Source: PNL 1988.

Workforce doses (on a weekly basis) directly associated with processing/storage normal operations were taken from reports prepared by Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory. To obtain the total workforce dose associated with a particular processing/storage process over its operational interim, the reported weekly dose is multiplied by the estimated number of weeks the particular process is to be in effect.

Radiological impacts to workers from postulated accident scenarios were evaluated at onsite locations where a given incident would cause the highest dose. For conservatism, the maximally exposed onsite worker was assumed to have an inhalation exposure time of 5 minutes and an external exposure time to soil contamination of 20 minutes. For a ground-level release accident, a maximally exposed onsite worker was assumed to be 100 meters from a given release point; for an elevated release, the worker was situated between 200 and 500 meters, depending on the given site's atmospheric dispersion characteristics. All doses to workers include a component associated with the intake of radioactivity into the body and another component resulting from external exposure to direct radiation.

D.1.2.3 Health Effects Calculations

In this EIS, the collective combined effective dose equivalent is the sum of the collective committed effective dose equivalent (internal dose) and the collective effective dose equivalent (external dose), as explained in Section D.1.1.1. Doses calculated by GENII were used to estimate health effects using the risk estimators presented in Section D.1.1.2. The incremental cancer fatalities in the general population and in groups of workers caused by radiation exposure were, therefore, estimated by multiplying the collective combined effective dose equivalent by 0.0005 and 0.0004 fatal cancers/person-rem, respectively, for normal operations and also for accidents in which doses to members of the population were less than 20 rem. For situations in which the dose was greater than 20 rem, these factors were doubled. Although health risk factors are statistical factors and not strictly applicable to individuals, they have been used in the past to estimate the incremental risk to an individual from exposure to radiation. Therefore, the factor of 0.0005 and 0.0004 per rem of individual committed effective dose equivalent for a member of the public and for a worker, respectively (or double these values for individual doses greater than 20 rem), have also been used in this EIS to calculate the individual's incremental fatal cancer risk from exposure to radiation.

For the public, the health effects expressed in this EIS are the risk of fatal cancers to the maximally exposed individual and the number of fatal cancers to the 80-km (50-mi) population from exposure to radioactivity released from any site over the full operational period. For workers, the health effects expressed are the risk

to the average worker at a site and the number of fatal cancers to all workers at that site over the full period of site operations.

D.1.2.4 Uncertainties

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

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

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

Uncertainties are also derived from the lack of engineering design data for facilities that are only conceptual. Although the radionuclide composition of source terms are reasonable estimates, there are uncertainties in the radionuclide inventory and release reactions that affect estimated impacts.

D.1.3 Radiological Impact Assessment Data

This section presents the various site-dependent GENII input data required for quantifying the potential radiological impacts associated with the processing/storage alternatives discussed in this EIS. Agricultural data, population data, meteorological data, and atmospheric dispersion characteristics are presented for Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory.

- **Agricultural Data—**Agricultural food production data (wheels) were generated based on the results of the 1987 and 1992 U.S. Censuses of Agriculture (DOC 1988; DOC 1993). The wheel was generated by combining the fraction of a county in each segment (e.g., south, southwest, north-northeast) and the county production of the eight food categories analyzed by GENII (leafy vegetables, root vegetables, fruits, grains, beef, poultry, milk, and eggs). Each county's food production (in kilograms) was assumed to be distributed uniformly over the given county's land area. These categorized food wheels are fed into

GENII as an input file and are used in the assessment of doses to a given general population from the ingestion pathway. For further discussion, see Section D.1.2.2.

- **Population Data—**Population data (wheels) were generated based on the 1990 U.S. Census of Population and Housing (DOC 1992). For each block in the 1990 census, the population was assigned a distance and direction from the release point; then the block's population was projected based on state estimates of county growth rates through the year 2000. The population in each segment (e.g., south, southwest, north-northeast) was cumulated over all the blocks in the census. These population wheels are fed into GENII as an input file and are used in the assessment of a total dose incurred to a given general population. For further discussion, see Section D.1.2.2.

- **Meteorological Data—**Meteorological data (i.e., Joint Frequency Distributions) were based on measurements of the fractions of time (given as percentages) the wind blows in a certain direction, at a certain speed, and within a certain stability class for each site examined within this EIS. These data are fed into GENII as an input file and are used in the evaluation of ÷/Q or E/Q values (these values represent radioisotope concentrations divided by the rates at which they are emitted to the environment), which are used to determine the total dose incurred to a given general population, an offsite maximally exposed individual, or an onsite worker.

D.1.3.1 Radiological Impact Assessments at Rocky Flats

This section presents the radiological impact input data used in the assessment of the various processing/ storage alternatives at Rocky Flats. For purposes of radiological impact modeling, the Rocky Flats analyses assumed that Buildings 707 and 371 would be the locations from which radioactive effluents would be released. **Table D–8** presents the characteristics of both these release points, including location, release height, minimum distance, and annual average dispersion to the site boundary in each of 16 directions.

Table D–8 Release Point Characteristics, Direction, Distance, and Atmospheric Dispersion at the Rocky Flats Site Boundary

Release Location	***Building 707***		***Building 371***	
Latitude [a]	39.89°		39.89°	
Longitude [a]	-105.20°		-105.20°	
Release Height	12.4 m		44.2 m	
Distance and Atmospheric Dispersion at Site Boundary				
	Building 707		***Building 371***	
Direction	***Distance (m)***	***÷/Q (sec/m^3)***	***Distance (m)***	***÷/Q (sec/m^3)***
N	2,350	1.0×10^{-7}	2,310	2.5×10^{-7}
NNE	2,540	7.6×10^{-8}	2,340	2.0×10^{-7}
NE	2,730	5.3×10^{-8}	2,720	1.1×10^{-7}
ENE	3,120	3.9×10^{-8}	3,270	8.1×10^{-8}
E	3,060	3.0×10^{-8}	3,620	5.6×10^{-8}
ESE	3,120	3.2×10^{-8}	3,720	6.0×10^{-8}
SE	2,880	5.0×10^{-8}	3,220	1.0×10^{-7}
SSE	2,440	7.5×10^{-8}	2,670	1.7×10^{-7}
S	2,380	8.9×10^{-8}	2,610	2.2×10^{-7}
SSW	2,440	1.0×10^{-7}	2,460	2.5×10^{-7}
SW	2,140	1.3×10^{-7}	1,610	6.0×10^{-7}
WSW	1,940	2.1×10^{-7}	1,740	7.1×10^{-7}
W	2,980	1.3×10^{-7}	2,560	3.8×10^{-7}
WNW	3,030	1.3×10^{-7}	2,620	3.6×10^{-7}
NW	2,930	8.9×10^{-8}	2,360	3.1×10^{-7}

Distance and Atmospheric Dispersion at Site Boundary				
	Building 707		*Building 371*	
Direction	*Distance (m)*	*÷/Q (sec/m³)*	*Distance (m)*	*÷/Q (sec/m³)*
NNW	2,410	1.1×10^{-7}	2,360	2.7×10^{-7}

÷/Q = Radioisotope concentrations divided by the rates at which they are emitted to the environment
sec/m^3 = seconds per cubic meter

[a] The distance between Buildings 707 and 371 is approximately 500 meters. Because of this small distance, the coordinates are the same to the accuracy given.

Source: DOE 1995b, DOE 1996e, PNL 1988.

Descriptions of population and foodstuff distributions centered on Rocky Flats are provided in **Table D–9** and **Table D–10**, respectively. The joint frequency distribution used for the dose assessment (presented in **Table D–11**) was based on the meteorological measurements for 1994 and 1996 taken from the meteorological tower at Rocky Flats at the 10-m (33-ft) height.

Table D–9 Rocky Flats Population Data Out to 80 km (50 mi) for Year 2000

	Distance (miles)										
Direction	*0-1*	*1-2*	*2-3*	*3-4*	*4-5*	*5-10*	*10-20*	*20-30*	*30-40*	*40-50*	*Total*
S	0	0	164	466	519	10,777	41,364	18,942	4,306	3,544	**80,082**
SSW	0	0	164	308	229	438	12,822	8,927	2,551	1,945	**27,384**
SW	0	0	90	56	61	499	3,682	1,227	1,054	1,281	**7,950**
WSW	0	0	21	55	58	500	1,623	2,765	1,890	8,392	**15,304**
W	0	0	53	68	58	496	3,898	1,343	1,112	893	**7,921**
WNW	0	0	21	53	66	418	1,497	1,604	388	1,833	**5,880**
NW	0	0	38	35	144	970	1,490	3,322	5	2,599	**8,603**
NNW	0	0	73	81	211	58,878	29,949	4,208	7,627	5,545	**106,572**
N	0	0	46	94	493	8,207	21,684	17,222	50,176	115,674	**213,596**
NNE	0	0	77	143	595	21,060	22,519	34,494	8,747	11,876	**99,511**
NE	0	0	107	410	200	15,797	3,852	3,772	2,631	85,090	**111,859**
ENE	0	0	5	100	11	28,481	21,467	25,953	3,255	2,106	**81,378**
E	0	0	6	1,315	5,954	41,207	98,629	4,323	3,253	3,031	**157,718**
ESE	0	0	21	223	192	65,014	103,130	137,283	4,034	1,124	**311,021**
SE	0	0	10	500	3,675	58,471	308,362	316,464	53,246	7,366	**748,094**
SSE	0	0	171	857	1,742	25,320	211,024	179,144	17,158	16,678	**452,094**
Total	**0**	**0**	**1,067**	**4,764**	**14,208**	**336,533**	**886,992**	**760,993**	**161,433**	**268,977**	**2,434,967**

Source: KHC 1997c.

Table D–10 Rocky Flats Agricultural Data (kg/yr)

	Distance (miles)										
Food Type	*0-1*	*1-2*	*2-3*	*3-4*	*4-5*	*5-10*	*10-20*	*20-30*	*30-40*	*40-50*	*Direction*
Leafy Veg.	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	0	0	0	WNW
	0	0	0	0	0	0	0	0	0	0	NW

Food Type	Distance (miles)										Direction
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	
	0	0	0	0	0	0	0	0	0	0	NNW
	0	0	0	0	0	0	0	0	0	0	N
	0	0	0	0	0	0	0	0	0	0	NNE
	0	0	0	0	0	0	0	0	0	0	NE
	0	0	0	0	0	0	0	0	0	0	ENE
	0	0	0	0	0	0	0	0	0	0	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Root Veg.	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	4,900	19,000	32,000	360,000	1.30×10^{6}	1.50×10^{6}	0	0	WNW
	0	0	34,000	38,000	48,000	400,000	1.60×10^{6}	2.40×10^{6}	980,000	400,000	NW
	0	14,000	27,000	38,000	48,000	400,000	160×10^{6}	2.60×10^{6}	3.00×10^{6}	3.80×10^{6}	NNW
	0	16,000	27,000	38,000	48,000	400,000	1.60×10^{6}	2.40×10^{6}	3.00×10^{6}	3.80×10^{6}	N
	0	15,000	27,000	38,000	48,000	400,000	1.90×10^{6}	7.10×10^{6}	8.60×10^{6}	1.30×10^{7}	NNE
	0	11,000	27,000	38,000	48,000	400,000	6.30×10^{6}	1.30×10^{7}	1.80×10^{7}	2.30×10^{7}	NE
	0	0	19,000	36,000	48,000	380,000	4.30×10^{6}	1.20×10^{7}	1.80×10^{7}	2.30×10^{7}	ENE
	0	0	0	680	7,400	190,000	990,000	2.10×10^{6}	5.60×10^{6}	9.50×10^{6}	E
	0	0	0	0	0	86,000	890,000	1.40×10^{6}	1.30×10^{6}	1.10×10^{6}	ESE
	0	0	0	0	0	7,600	120,000	45,000	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Fruits	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
Fruits (continued)	0	0	0	0	0	0	0	0	0	0	W
	0	0	0.360	1.40	2.40	27.0	99.0	110	0	0	WNW
	0	0	2.50	2.80	3.60	30.0	120	180	50.0	0	NW
	0	1.00	2.00	2.80	3.60	30.0	120	160	8.40	0	NNW
	0	1.20	2.00	2.80	3.60	30.0	120	110	0	0	N
	0	1.10	2.00	2.80	3.60	30.0	110	85.0	18.0	28.0	NNE
	0	0.850	2.00	2.80	3.60	30.0	42.0	33.0	46.0	60.0	NE
	0	0	1.40	2.70	3.60	25.0	10.0	32.0	46.0	60.0	ENE
	0	0	0	0	0	6.20	0	1.30	10.0	20.0	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Grains	0	390	480	680	870	7,300	29,000	66,000	220,000	390,000	S
	0	390	480	680	870	7,300	29,000	39,000	33,000	28,000	SSW
	0	390	480	680	870	7,300	16,000	260	0	0	SW
	0	390	480	680	870	7,300	3,200	0	0	0	WSW
	0	0	870	680	870	7,100	210	0	0	0	W
	0	0	11,000	40,000	68,000	760,000	2.80×10^{6}	3.10×10^{6}	0	0	WNW
	0	0	70,000	79,000	100,000	850,000	3.40×10^{6}	5.00×10^{6}	1.90×10^{6}	670,000	NW
	0	29.000	57,000	79,000	100,000	850,000	3.40×10^{6}	5.30×10^{6}	5.10×10^{6}	6.40×10^{6}	NNW
	0	33,000	57,000	79,000	100,000	850,000	3.40×10^{6}	4.70×10^{6}	5.00×10^{6}	6.40×10^{6}	N
	0	32,000	57,000	79,000	100,000	850,000	3.80×10^{6}	1.10×10^{7}	1.30×10^{7}	1.90×10^{7}	NNE
	0	24,000	57,000	79,000	100,000	850,000	9.70×10^{6}	1.90×10^{7}	2.70×10^{7}	3.40×10^{7}	NE

Food Type	Distance (miles)										Direction
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	
	0	0	40,000	76,000	100,000	1.20×10^{6}	1.10×10^{7}	1.90×10^{7}	2.70×10^{7}	3.40×10^{7}	ENE
	0	0	870	2,100	16.000	1.40×10^{6}	1.10×10^{7}	1.80×10^{7}	2.60×10^{7}	3.40×10^{7}	E
	0	0	870	680	870	960,000	9.90×10^{6}	1.60×10^{7}	1.80×10^{7}	1.80×10^{7}	ESE
	0	0	870	680	870	92,000	1.40×10^{6}	4.20×10^{6}	4.60×10^{6}	3.80×10^{6}	SE
	0	390	480	680	870	7,300	62,000	2.60×10^{6}	360,000	550,000	SSE
Meats	0	0	0	0	0	0	0	75,000	660,000	1.30×10^{6}	S
	0	0	0	0	0	0	0	63,000	320,000	550,000	SSW
	0	0	0	0	0	0	12,000	59,000	540,000	800,000	SW
	0	0	0	0	0	0	130,000	16,000	54,000	170,000	WSW
	0	0	0	0	0	1,100	180,000	440,000	1.10×10^{6}	1.30×10^{6}	W
	0	0	3,200	12,000	21,000	230,000	900,000	1.30×10^{6}	1.30×10^{6}	1.60×10^{6}	WNW
	0	0	21,000	24,000	31,000	260,000	1.00×10^{6}	1.60×10^{6}	1.50×10^{6}	1.60×10^{6}	NW
	0	0	26,000	24,000	31,000	260,000	1.00×10^{6}	1.60×10^{6}	1.30×10^{6}	1.60×10^{6}	NNW
	0	10,000	17,000	24,000	31,000	260,000	1.00×10^{6}	1.40×10^{6}	1.30×10^{6}	1.60×10^{6}	N
	0	9,800	17,000	24,000	31,000	260,000	1.10×10^{6}	1.70×10^{6}	1.90×10^{6}	2.60×10^{6}	NNE
	0	7,500	17,000	24,000	31,000	260,000	1.20×10^{6}	2.10×10^{6}	2.90×10^{6}	3.80×10^{6}	NE
	0	0	11,000	24,000	31,000	240,000	860,000	2.10×10^{6}	2.90×10^{6}	3.80×10^{6}	ENE
	0	0	0	440	4,800	100,000	470,000	840,000	1.50×10^{6}	2.20×10^{6}	E
	0	0	0	0	0	41,000	420,000	650,000	620,000	530,000	ESE
	0	0	0	0	0	3,600	58,000	21,000	540,000	3.00×10^{6}	SE
	0	0	0	0	0	0	0.000190	320,000	1.30×10^{6}	1.70×10^{6}	SSE
Poultry	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	0	0	0	WNW
	0	0	0	0	0	0	0	0	36.0	46.0	NW
Poultry (continued)	0	0	0	0	0	0	0	44.0	330	440	NNW
	0	0	0	0	0	0	0	110	340	440	N
	0	0	0	0	0	0	3.80	100	270	330	NNE
	0	0	0	0	0	0	54.0	110	160	210	NE
	0	0	0	0	0	1.10	47.0	110	160	210	ENE
	0	0	0	0	0	2.70	25.0	45.0	81.0	120	E
	0	0	0	0	0	2.20	23.0	49.0	110	180	ESE
	0	0	0	0	0	0.190	3.10	100	120	34.0	SE
	0	0	0	0	0	0	1.10	68.0	0.0750	0	SSE
Milk	0	0	0	0	0	0	0	820	7,200	15,000	S
	0	0	0	0	0	0	0	190	980	1,700	SSW
	0	0	0	0	0	0	0	140	1,700	2,500	SW
	0	0	0	0	0	0	0	0	150	740	WSW
	0	0	0	0	0	0	0	1,600	5,300	6,700	W
	0	0	9,600	37,000	64,000	710,000	2.70×10^{6}	2.90×10^{6}	6,300	8,100	WNW
	0	0	66,000	75,000	96,000	800,000	3.20×10^{6}	4.70×10^{6}	1.70×10^{6}	490,000	NW
	0	28,000	53,000	75,000	96,000	800,000	3.20×10^{6}	4.80×10^{6}	3.70×10^{6}	4.60×10^{6}	NNW
	0	31,000	53,000	75,000	96,000	800,000	3.20×10^{6}	4.00×10^{6}	3.60×10^{6}	4.60×10^{6}	N
	0	30,000	53,000	75,000	96,000	800,000	3.20×10^{6}	5.30×10^{6}	5.70×10^{6}	8.00×10^{6}	NNE
	0	23,000	53,000	75,000	96,000	800,000	3.80×10^{6}	6.60×10^{6}	9.20×10^{6}	1.20×10^{7}	NE
	0	0	38,000	72,000	96,000	710,000	2.50×10^{6}	6.40×10^{6}	9.20×10^{6}	1.20×10^{7}	ENE
	0	0	0	1,400	15,000	280,000	1.10×10^{6}	2.10×10^{6}	4.00×10^{6}	6.10×10^{6}	E
	0	0	0	0	0	97,000	1.00×10^{6}	1.60×10^{6}	1.50×10^{6}	1.30×10^{6}	ESE
	0	0	0	0	0	8,600	140,000	51,000	21,000	380,000	SE

Food Type	Distance (miles)										Direction
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	
	0	0	0	0	0	0	0	3,500	14,000	33,000	SSE
Eggs	0	25	31	44	56	470	1,900	3,000	2,800	2,500	S
	0	25	31	44	56	470	1,900	2,500	2,200	1,900	SSW
	0	25	31	44	56	470	1,100	26.0	110	170	SW
	0	25	31	44	56	470	200	0	12.0	65.0	WSW
	0	0	56.0	44	56	460	13.0	130	430	540	W
	0	0	51.0	22.0	19.0	44.0	0	160	510	650	WNW
	0	0	19.0	0	0	0	0	44.0	580	870	NW
	0	8.80	0	0	0	0	0	270	2,000	2,700	NNW
	0	6.90	0	0	0	0	0	700	2,100	2,700	N
	0	7.50	0	0	0	0	0	300	1,300	1,400	NNE
	0	12.0	0	0	0	0	0	0	0	0	NE
	0	0	34.0	1.70	0	0	0	0	0	0	ENE
	0	0	56.0	43.0	48.0	170	0	0	0	0	E
	0	0	56.0	44.0	56.0	310	0	0	0	0	ESE
	0	0	56.0	44.0	56.0	450	110	0	450	170	SE
	0	25.0	31.0	44.0	56.0	470	1,200	680	1,400	1,700	SSE

kg/yr = kilogram per year
Source: DOC 1993.

Table D–11 Rocky Flats 1994-1996 Joint Frequency Distributions at 10-m (33-ft) Height

Wind Speed (m/sec)	Stability Class	Wind Blows Toward															
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
1.4	A	0.11	0.15	0.13	0.09	0.07	0.11	0.08	0.1	0.15	0.17	0.14	0.24	0.17	0.16	0.22	0.15
	B	0.03	0.01	0.02	0.02	0.06	0.02	0	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.02
	C	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
	D	0.02	0.07	0.11	0.22	0.11	0.07	0.02	0.02	0.02	0.03	0.05	0.09	0	0.01	0.02	0.03
	E	0.05	0.09	0.09	0.2	0.07	0.07	0.02	0.06	0.05	0.06	0.05	0.02	0.02	0.03	0.03	0.01
	F	0.24	0.24	0.34	0.38	0.38	0.28	0.23	0.16	0.16	0.13	0.06	0.1	0.11	0.1	0.16	0.17
2.6	A	0.25	0.17	0.2	0.15	0.14	0.16	0.14	0.28	0.55	0.69	0.72	0.9	1.06	1.05	0.87	0.43
	B	0.11	0.06	0.1	0.07	0.05	0.05	0.06	0.08	0.36	0.36	0.22	0.2	0.22	0.31	0.36	0.18
	C	0.17	0.06	0.06	0.05	0.06	0.07	0.13	0.16	0.18	0.24	0.11	0.07	0.08	0.11	0.23	0.25
	D	0.44	0.67	0.71	0.87	0.92	0.56	0.31	0.33	0.33	0.34	0.31	0.3	0.18	0.11	0.31	0.37
	E	0.31	0.45	0.54	0.94	0.54	0.38	0.26	0.22	0.2	0.13	0.18	0.08	0.08	0.08	0.15	0.15
	F	0.43	0.51	0.45	0.47	0.55	0.64	0.59	0.51	0.47	0.33	0.24	0.26	0.22	0.34	0.33	0.45
4.4	A	0.01	0	0.01	0.01	0	0.02	0.01	0.03	0.01	0.01	0	0	0	0	0.01	0
	B	0.13	0.13	0.07	0.09	0.11	0.11	0.21	0.25	0.43	0.67	0.56	0.41	0.47	0.64	0.64	0.33
	C	0.17	0.09	0.14	0.09	0.17	0.17	0.29	0.41	0.91	0.52	0.39	0.29	0.24	0.45	0.6	0.57
	D	0.93	0.94	0.93	1.22	1.14	1.18	1.46	1.72	1.06	0.83	0.59	0.4	0.32	0.28	0.37	0.78
	E	0.43	0.49	0.56	0.74	0.37	0.51	0.65	0.37	0.15	0.17	0.14	0.13	0.08	0.02	0.05	0.13
	F	0.02	0.01	0.02	0.02	0.01	0.01	0.02	0.03	0.01	0	0.01	0	0	0	0	0
7	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0
	C	0.09	0.07	0.07	0.11	0.21	0.21	0.2	0.24	0.39	0.15	0.1	0.07	0.03	0.05	0.07	0.1
	D	0.67	0.55	0.84	1.34	1.84	2.7	1.41	1.18	1.02	0.6	0.23	0.11	0.08	0.08	0.11	0.53
	E	0.08	0.05	0.05	0.05	0.02	0.07	0.06	0.09	0	0.01	0.01	0	0	0	0	0.01
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.8	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0.13	0.15	0.18	0.62	1.26	2.22	0.44	0.17	0.16	0.14	0.02	0.01	0	0.01	0	0.11
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0.02	0.05	0.07	0.49	2.4	2.24	0.2	0.02	0.02	0.01	0	0	0	0	0	0.06
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: KHC 1997b.

D.1.3.2 Radiological Impact Assessments at the Savannah River Site

This section presents the radiological impact input data used in the assessment of the various processing/ storage alternatives at the Savannah River Site. For purposes of radiological impact modeling, the Savannah River Site analyses used the assumption that either F-Area or H-Area could be the locations from which radioactive effluents would be released. **Table D–12** presents the characteristics of the release point, including location, release height, minimum distance, and annual average dispersion to the site boundary in each of 16 directions.

Table D–12 F-Area and H-Area Release Point Characteristics, Direction, Distance, and Atmospheric Dispersion at the Savannah River Site Boundary

Release Point	***F-Area***		***H-Area***	
Latitude	33.286°		33.286°	
Longitude	-81.676°		-81.640°	
Release Height	61 m		61 m	
Distance and Atmospheric Dispersion at Site Boundary				
Direction	***F-Area Distance (m)***	***÷/Q (sec/m^3)***	***H-Area Distance (m)***	***÷/Q (sec/m^3)***
N	10,898	1.6×10^{-8}	12,288	1.4×10^{-8}
NNE	12,665	1.1×10^{-8}	12,852	1.1×10^{-8}
NE	14,770	9.6×10^{-9}	14,883	9.5×10^{-9}
ENE	18,525	6.9×10^{-9}	15,959	8.4×10^{-9}
E	17,118	6.2×10^{-9}	14,047	8.0×10^{-9}
ESE	16,943	5.4×10^{-9}	13,688	7.1×10^{-9}
SE	19,771	3.0×10^{-9}	17,629	3.5×10^{-9}
SSE	18,933	2.6×10^{-9}	17,662	2.9×10^{-9}
S	18,516	1.7×10^{-9}	18,109	1.7×10^{-9}
SSW	15,467	5.9×10^{-9}	18,481	4.8×10^{-9}
SW	11,525	1.5×10^{-8}	14,355	1.1×10^{-8}
WSW	9,645	1.5×10^{-8}	14,212	8.8×10^{-9}
W	9,416	1.1×10^{-8}	12,763	7.2×10^{-9}
WNW	9,847	9.6×10^{-9}	12,643	7.1×10^{-9}
NW	9,448	1.3×10^{-8}	11,889	9.4×10^{-9}
NNW	9,972	1.6×10^{-8}	11,749	1.3×10^{-8}

÷/Q = Radioisotope concentrations divided by the rates at which they are emitted to the environment
sec/m^3 = second per cubic meter
Source: HNUS 1996, WSRC 1996a, PNL 1988.

Descriptions of population and foodstuff distributions centered on the F-Area are provided in **Table D–13** and **Table D–14**, respectively. Descriptions of population and foodstuff distributions centered on the H-Area are provided in **Tables D–15** and **D–16**, respectively. The joint frequency distribution used for the dose assessment (presented in **Table D–17**) was based on the meteorological measurements for 1987 through 1991 from the meteorological tower at the Savannah River Site at the 61-m (201-ft) height.

Table D–13 Savannah River Site (F-Area) Population Data Out to 80 km (50 mi) for Year 2000

	Distance (miles)										
Direction	***0-1***	***1-2***	***2-3***	***3-4***	***4-5***	***5-10***	***10-20***	***20-30***	***30-40***	***40-50***	***Total***
S	0	0	0	0	0	0	570	1,980	3,289	5,995	**11,834**
SSW	0	0	0	0	0	36	864	1,742	4,721	3,726	**11,089**
SW	0	0	0	0	0	80	1,170	7,477	1,818	6,516	**17,061**
WSW	0	0	0	0	0	183	3,242	3,465	3,510	8,317	**18,717**
W	0	0	0	0	0	297	7,168	39,152	18,993	22,459	**88,069**
WNW	0	0	0	0	0	2,020	9,675	186,036	47,704	7,923	**253,358**
NW	0	0	0	0	0	1,216	15,680	35,012	2,627	4,589	**59,124**
NNW	0	0	0	0	0	2,668	32,691	19,807	8,828	9,247	**73,241**
N	0	0	0	0	0	945	6,680	5,442	5,159	22,630	**40,856**
NNE	0	0	0	0	0	103	1,653	2,487	5,712	25,161	**35,116**
NE	0	0	0	0	0	0	2,922	3,516	5,486	12,551	**24,475**
ENE	0	0	0	0	0	0	2,811	5,675	7,700	38,820	**55,006**
E	0	0	0	0	0	0	5,776	5,167	7,094	6,563	**24,600**
ESE	0	0	0	0	0	0	917	3,896	4,870	8,845	**18,528**
SE	0	0	0	0	0	0	544	1,896	3,798	8,461	**14,699**
SSE	0	0	0	0	0	0	369	667	4,352	4,215	**9,603**
Total	**0**	**0**	**0**	**0**	**0**	**7,548**	**92,732**	**323,417**	**135,661**	**196,018**	**755,376**

Source: DOC 1992.

Table D–14 Savannah River Site (F-Area) Agricultural Data (kg/yr)

	Distance (miles)										
Food Type	***0-1***	***1-2***	***2-3***	***3-4***	***4-5***	***5-10***	***10-20***	***20-30***	***30-40***	***40-50***	***Direction***
Leafy Veg.	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	340,000	0	0	0	1,100	SW
	0	0	0	0	0	370	33.0	0	1,600	8,800	WSW
	0	0	0	0	0	1,300	130	0	2,800	4,100	W
	0	0	0	0	0	1,400	3,400	0	0	0	WNW
	0	0	0	0	0	1,400	6,300	4,700	0	0	NW
	0	0	0	0	0	1,300	6,900	8,700	8.60	2,400	NNW
	0	0	0	0	0	1,100	6,900	12,000	11,000	48,000	N
	0	0	0	0	0	590	6,900	12,000	310,000	960,000	NNE
	0	0	0	0	0	46.0	6,000	31,000	250,000	770,000	NE
	0	0	0	0	0	0	7.60	32,000	160,000	210,000	ENE
	0	0	0	0	0	0	0	0	23,000	130,000	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Root Veg.	0	0	0	0	0	0	1.80×10^{6}	3.10×10^{6}	4.10×10^{6}	6.30×10^{6}	S
	0	0	0	0	0	3,100	2.10×10^{6}	3.40×10^{6}	4.30×10^{6}	6.70×10^{6}	SSW
	0	0	0	0	0	9.70×10^{7}	2.20×10^{6}	3.60×10^{6}	4.80×10^{6}	5.80×10^{6}	SW
	0	0	0	0	0	110,000	2.10×10^{6}	3.60×10^{6}	5.30×10^{6}	8.00×10^{6}	WSW
	0	0	0	0	0	180,000	230,000	1.30×10^{6}	3.40×10^{6}	4.40×10^{6}	W
	0	0	0	0	0	190,000	500,000	110,000	54,000	320,000	WNW
	0	0	0	0	0	200,000	880,000	820,000	400,000	140,000	NW
	0	0	0	0	0	190,000	960,000	1.30×10^{6}	730,000	1.20×10^{6}	NNW

	Distance (miles)										
Food Type	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**	**Direction**
Root Veg. (continued)	0	0	0	0	0	150,000	960,000	1.60×10^{6}	1.70×10^{6}	2.40×10^{6}	N
	0	0	0	0	0	81,000	960,000	1.60×10^{6}	2.50×10^{6}	3.80×10^{6}	NNE
	0	0	0	0	0	6,300	1.20×10^{6}	2.60×10^{6}	4.20×10^{6}	5.10×10^{6}	NE
	0	0	0	0	0	0	3.40×10^{6}	6.30×10^{6}	7.80×10^{6}	9.90×10^{6}	ENE
	0	0	0	0	0	0	3.60×10^{6}	6.30×10^{6}	7.90×10^{6}	1.00×10^{7}	E
	0	0	0	0	0	0	3.30×10^{6}	6.60×10^{6}	8.40×10^{6}	5.30×10^{6}	ESE
	0	0	0	0	0	0	6.40×10^{7}	6.80×10^{6}	8.80×10^{6}	9.20×10^{6}	SE
	0	0	0	0	0	0	3.80×10^{7}	3.00×10^{7}	6.70×10^{6}	7.80×10^{6}	SSE
Fruits	0	0	0	0	0	0	390,000	1.10×10^{6}	1.70×10^{6}	2.50×10^{6}	S
	0	0	0	0	0	690	450,000	870,000	1.40×10^{6}	2.30×10^{6}	SSW
	0	0	0	0	0	3.30×10^{7}	480,000	790,000	1.20×10^{6}	1.20×10^{6}	SW
	0	0	0	0	0	44,000	470,000	790,000	1.00×10^{6}	880,000	WSW
	0	0	0	0	0	110,000	45,000	270,000	440,000	390,000	W
	0	0	0	0	0	120,000	280,000	1,100	230	1,300	WNW
	0	0	0	0	0	120,000	530,000	2.80×10^{6}	6.60×10^{6}	2.20×10^{6}	NW
	0	0	0	0	0	110,000	580,000	2.80×10^{6}	1.20×10^{7}	1.40×10^{7}	NNW
	0	0	0	0	0	90,000	580,000	970,000	5.10×10^{6}	4.80×10^{6}	N
	0	0	0	0	0	49,000	580,000	970,000	1.00×10^{6}	740,000	NNE
	0	0	0	0	0	3,900	530,000	890,000	1.00×10^{6}	750,000	NE
	0	0	0	0	0	0	250,000	490,000	850,000	1.10×10^{6}	ENE
	0	0	0	0	0	0	260,000	340,000	160,000	700,000	E
	0	0	0	0	0	0	240,000	400,000	180,000	56,000	ESE
	0	0	0	0	0	0	4.30×10^{6}	310,000	370,000	310,000	SE
	0	0	0	0	0	0	2.60×10^{6}	2.00×10^{6}	1.10×10^{6}	1.00×10^{6}	SSE
Grains	0	0	0	0	0	0	2.60×10^{6}	7.40×10^{6}	1.10×10^{7}	1.50×10^{7}	S
	0	0	0	0	0	4,500	2.90×10^{6}	6.00×10^{6}	1.10×10^{7}	1.40×10^{7}	SSW
	0	0	0	0	0	1.10×10^{8}	3.10×10^{6}	5.10×10^{6}	8.20×10^{6}	1.00×10^{7}	SW
	0	0	0	0	0	140,000	3.00×10^{6}	5.10×10^{6}	8.10×10^{6}	1.50×10^{7}	WSW
	0	0	0	0	0	210,000	640,000	2.20×10^{6}	6.10×10^{6}	7.90×10^{6}	W
	0	0	0	0	0	220,000	760,000	720,000	260,000	650,000	WNW
	0	0	0	0	0	220,000	1.00×10^{6}	1.20×10^{6}	750,000	330,000	NW
	0	0	0	0	0	210,000	1.10×10^{6}	1.60×10^{6}	1.30×10^{6}	2.00×10^{6}	NNW
	0	0	0	0	0	170,000	1.10×10^{6}	1.80×10^{6}	2.30×10^{6}	4.10×10^{6}	N
	0	0	0	0	0	93,000	1.10×10^{6}	1.80×10^{6}	2.70×10^{6}	3.60×10^{6}	NNE
	0	0	0	0	0	7,300	1.30×10^{6}	3.60×10^{6}	6.10×10^{6}	6.90×10^{6}	NE
	0	0	0	0	0	0	4.00×10^{6}	8.70×10^{6}	1.40×10^{7}	1.80×10^{7}	ENE
	0	0	0	0	0	0	4.20×10^{6}	9.00×10^{6}	1.60×10^{7}	1.90×10^{7}	E
	0	0	0	0	0	0	3.90×10^{6}	8.90×10^{6}	1.60×10^{7}	1.20×10^{7}	ESE
	0	0	0	0	0	0	8.20×10^{7}	1.10×10^{7}	1.50×10^{7}	1.70×10^{7}	SE
	0	0	0	0	0	0	5.20×10^{7}	5.20×10^{7}	1.30×10^{7}	1.60×10^{7}	SSE
Beef	0	0	0	0	0	0	120,000	460,000	730,000	990,000	S
	0	0	0	0	0	220	150,000	340,000	690,000	930,000	SSW
	0	0	0	0	0	6.00×10^{6}	150,000	250,000	460,000	610,000	SW
	0	0	0	0	0	10,000	150,000	250,000	410,000	790,000	WSW
	0	0	0	0	0	21,000	40,000	120,000	340,000	510,000	W
	0	0	0	0	0	22,000	70,000	50,000	95,000	180,000	WNW
	0	0	0	0	0	23,000	110,000	140,000	160,000	210,000	NW
	0	0	0	0	0	22,000	110,000	180,000	230,000	350,000	NNW
	0	0	0	0	0	17,000	110,000	190,000	310,000	650,000	N
	0	0	0	0	0	9,600	110,000	190,000	250,000	290,000	NNE

	Distance (miles)										
Food Type	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**	**Direction**
Beef (continued)	0	0	0	0	0	750	100,000	260,000	430,000	500,000	NE
	0	0	0	0	0	0	24,000	220,000	820,000	1.10×10^{6}	ENE
	0	0	0	0	0	0	26,000	140,000	520,000	880,000	E
	0	0	0	0	0	0	24,000	82,000	340,000	450,000	ESE
	0	0	0	0	0	0	480,000	64,000	200,000	520,000	SE
	0	0	0	0	0	0	360,000	580,000	430,000	670,000	SSE
Poultry	0	0	0	0	0	0	0	0	0	54,000	S
	0	0	0	0	0	0	0	0	0	67,000	SSW
	0	0	0	0	0	4.70×10^{7}	0	0	0	45.0	SW
	0	0	0	0	0	51,000	4,500	0	61.0	350	WSW
	0	0	0	0	0	170,000	18,000	0	110	160	W
	0	0	0	0	0	190,000	460,000	0	0	5,100	WNW
	0	0	0	0	0	190,000	860,000	640,000	0	300,000	NW
	0	0	0	0	0	180,000	940,000	1.20×10^{6}	1,200	540,000	NNW
	0	0	0	0	0	150,000	940,000	1.60×10^{6}	1.70×10^{6}	3.60×10^{6}	N
	0	0	0	0	0	80,000	940,000	1.60×10^{6}	1.30×10^{6}	5,400	NNE
	0	0	0	0	0	6,300	820,000	1.20×10^{6}	970,000	0	NE
	0	0	0	0	0	0	1,100	0	0	0	ENE
	0	0	0	0	0	0	0	0	0	0	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Milk	0	0	0	0	0	0	550,000	620,000	650,000	760,000	S
	0	0	0	0	0	970	640,000	2.90×10^{6}	7.90×10^{6}	8.10×10^{6}	SSW
	0	0	0	0	0	3.20×10^{6}	670,000	1.10×10^{6}	3.80×10^{6}	2.90×10^{6}	SW
	0	0	0	0	0	22,000	660,000	1.10×10^{6}	2.00×10^{6}	4.40×10^{6}	WSW
	0	0	0	0	0	12,000	49,000	380,000	1.80×10^{6}	3.50×10^{6}	W
	0	0	0	0	0	13,000	31,000	0	47,000	1.20×10^{6}	WNW
	0	0	0	0	0	13,000	58,000	440,000	1.10×10^{6}	790,000	NW
	0	0	0	0	0	12,000	64,000	430,000	2.00×10^{6}	3.30×10^{6}	NNW
	0	0	0	0	0	9,900	64,000	110,000	1.90×10^{6}	7.40×10^{6}	N
	0	0	0	0	0	5,400	64,000	110,000	390,000	970,000	NNE
	0	0	0	0	0	420	55,000	690,000	1.70×10^{6}	1.80×10^{6}	NE
	0	0	0	0	0	0	70.0	1.10×10^{6}	4.60×10^{6}	5.60×10^{6}	ENE
	0	0	0	0	0	0	0	960,000	4.20×10^{6}	5.70×10^{6}	E
	0	0	0	0	0	0	0	320,000	2.60×10^{6}	1.60×10^{6}	ESE
	0	0	0	0	0	0	24,000	12,000	42,000	120,000	SE
	0	0	0	0	0	0	200,000	320,000	350,000	390,000	SSE
Eggs	0	0	0	0	0	0	630	0	0	83,000	S
	0	0	0	0	0	0	0	0	0	100,000	SSW
	0	0	0	0	0	620,000	0	0	0	91.0	SW
	0	0	0	0	0	0	0	0	120	700	WSW
	0	0	0	0	0	0	0	0	220	330	W
	0	0	0	0	0	0	0	0	0	0	WNW
	0	0	0	0	0	0	0	120,000	320,000	110,000	NW
	0	0	0	0	0	0	0	100,000	590,000	640,000	NNW
	0	0	0	0	0	0	0	0	170,000	29.0	N
	0	0	0	0	0	0	0	0	0	0	NNE
	0	0	0	0	0	0	4,100	4,000	160	120	NE
Eggs (continued)	0	0	0	0	0	0	43,000	55,000	500	630	ENE
	0	0	0	0	0	0	45,000	56,000	71.0	400	E

Food Type	Distance (miles)										Direction
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	
	0	0	0	0	0	0	42,000	58,000	120	0	ESE
	0	0	0	0	0	0	630,000	1,200	0	0	SE
	0	0	0	0	0	0	310,000	0	0	0	SSE

kg/yr = kilogram per year
Source: HNUS 1996.

Table D–15 Savannah River Site (H-Area) Population Data Out to 80 km (50 mi) for Year 2000

Direction	Distance (miles)										Total
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	
S	0	0	0	0	0	0	480	1,800	5,200	3,500	**10,980**
SSW	0	0	0	0	0	0	620	1,900	5,100	2,400	**10,020**
SW	0	0	0	0	0	25	880	7,500	1,900	2,900	**13,205**
WSW	0	0	0	0	0	66	2,300	4,400	3,300	8,200	**18,266**
W	0	0	0	0	0	630	4,300	52,000	21,000	13,000	**90,930**
WNW	0	0	0	0	0	1,300	7,300	160,000	72,000	6,500	**247,100**
NW	0	0	0	0	0	950	13,000	32,000	3,900	3,500	**53,350**
NNW	0	0	0	0	0	2,500	28,000	22,000	8,000	6,100	**66,600**
N	0	0	0	0	0	330	3,700	3,500	4,500	19,000	**31,030**
NNE	0	0	0	0	0	82	1,600	2,800	6,000	20,000	**30,482**
NE	0	0	0	0	0	14	3,600	3,500	6,000	9,400	**22,514**
ENE	0	0	0	0	0	9	3,600	6,100	6,900	42,000	**58,609**
E	0	0	0	0	0	110	7,400	3,800	6,800	4,000	**22,110**
ESE	0	0	0	0	0	3	1,300	2,500	3,500	5,700	**13,003**
SE	0	0	0	0	0	0	540	4,800	4,800	8,100	**18,240**
SSE	0	0	0	0	0	0	370	590	1,900	2,700	**5,560**
Total	**0**	**0**	**0**	**0**	**0**	**6,019**	**78,990**	**309,190**	**160,800**	**157,000**	**711,999**

Source: DOC 1992.

Table D–16 Savannah River Site (H-Area) Agricultural Data (kg/yr)

Food Type	Distance (miles)										Direction
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	
Leafy Veg.	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	120,000	0	0	0	430	SW
	0	0	0	0	0	110,000	110,000	0	560	7,900	WSW
	0	0	0	0	0	750	1,100	0	1,800	4,800	W
	0	0	0	0	0	730	5,200	0	0	0	WNW
	0	0	0	0	0	990	6,800	7,100	0	0	NW
	0	0	0	0	0	1,000	6,900	10,000	450	4,000	NNW
	0	0	0	0	0	850	6,900	12,000	30,000	150,000	N
	0	0	0	0	0	610	6,900	12,000	410,000	960,000	NNE

	Distance (miles)										
Food Type	***0-1***	***1-2***	***2-3***	***3-4***	***4-5***	***5-10***	***10-20***	***20-30***	***30-40***	***40-50***	***Direction***
Leafy Veg. (continued)	0	0	0	0	0	110	4,700	47,000	290,000	700,000	NE
	0	0	0	0	0	0	0	44,000	170,000	200,000	ENE
	0	0	0	0	0	0	0	0	35,000	150,000	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Root Veg.	0	0	0	0	0	0	1.4×10^{7}	3.0×10^{6}	4.1×10^{6}	5.8×10^{6}	S
	0	0	0	0	0	0	1.8×10^{6}	3.4×10^{6}	4.3×10^{6}	6.9×10^{6}	SSW
	0	0	0	0	0	4.2×10^{7}	2.7×10^{7}	3.6×10^{6}	4.8×10^{6}	5.8×10^{6}	SW
	0	0	0	0	0	1.5×10^{7}	1.8×10^{7}	3.6×10^{6}	5.1×10^{6}	7.9×10^{6}	WSW
	0	0	0	0	0	100,000	420,000	950,000	3.1×10^{6}	4.8×10^{6}	W
	0	0	0	0	0	100,000	740,000	110,000	58,000	220,000	WNW
	0	0	0	0	0	140,000	950,000	1.1×10^{6}	490,000	280,000	NW
	0	0	0	0	0	140,000	960,000	1.5×10^{6}	770,000	1.3×10^{6}	NNW
	0	0	0	0	0	120,000	960,000	1.6×10^{6}	1.9×10^{6}	2.6×10^{6}	N
	0	0	0	0	0	85,000	960,000	1.6×10^{6}	2.6×10^{6}	3.8×10^{6}	NNE
	0	0	0	0	0	16,000	1.9×10^{6}	3.2×10^{6}	4.8×10^{6}	5.3×10^{6}	NE
	0	0	0	0	0	3,300	4.0×10^{6}	6.1×10^{6}	7.8×10^{6}	9.8×10^{6}	ENE
	0	0	0	0	0	170,000	4.0×10^{6}	6.1×10^{6}	7.9×10^{6}	1.0×10^{7}	E
	0	0	0	0	0	130,000	3.9×10^{6}	6.5×10^{6}	7.9×10^{6}	4.1×10^{6}	ESE
	0	0	0	0	0	0	3.4×10^{7}	6.8×10^{6}	8.3×10^{6}	9.0×10^{6}	SE
	0	0	0	0	0	0	8.3×10^{7}	5.4×10^{6}	7.4×10^{6}	8.2×10^{6}	SSE
Fruits	0	0	0	0	0	0	1.3×10^{6}	1.1×10^{6}	1.7×10^{6}	2.3×10^{6}	S
	0	0	0	0	0	0	410,000	880,000	1.4×10^{6}	2.4×10^{6}	SSW
	0	0	0	0	0	1.2×10^{7}	2.3×10^{6}	790,000	1.2×10^{6}	1.3×10^{6}	SW
	0	0	0	0	0	8.9×10^{6}	1.0×10^{7}	790,000	1.1×10^{6}	930,000	WSW
	0	0	0	0	0	63,000	140,000	190,000	480,000	460,000	W
	0	0	0	0	0	62,000	440,000	1,100	360	840	WNW
	0	0	0	0	0	83,000	580,000	2.4×10^{6}	8.2×10^{6}	4.6×10^{6}	NW
	0	0	0	0	0	84,000	580,000	1.8×10^{6}	1.2×10^{7}	1.3×10^{7}	NNW
	0	0	0	0	0	71,000	580,000	970,000	3.6×10^{6}	4.4×10^{6}	N
	0	0	0	0	0	52,000	580,000	970,000	930,000	730,000	NNE
	0	0	0	0	0	9,100	490,000	830,000	940,000	690,000	NE
	0	0	0	0	0	240	290,000	470,000	880,000	1.0×10^{6}	ENE
	0	0	0	0	0	13,000	290,000	240,000	220,000	810,000	E
	0	0	0	0	0	9,800	290,000	340,000	130,000	28,000	ESE
	0	0	0	0	0	0	2.3×10^{6}	310,000	330,000	300,000	SE
	0	0	0	0	0	0	4.9×10^{6}	640,000	890,000	790,000	SSE
Grains	0	0	0	0	0	0	1.7×10^{7}	7.7×10^{6}	1.1×10^{7}	1.5×10^{7}	S
	0	0	0	0	0	0	2.6×10^{6}	6.0×10^{6}	1.1×10^{7}	1.5×10^{7}	SSW
	0	0	0	0	0	4.9×10^{7}	3.2×10^{7}	5.1×10^{6}	8.4×10^{6}	1.0×10^{7}	SW
	0	0	0	0	0	1.7×10^{7}	2.1×10^{7}	5.1×10^{6}	7.5×10^{6}	1.4×10^{7}	WSW
	0	0	0	0	0	120,000	820,000	1.8×10^{6}	5.4×10^{6}	8.7×10^{6}	W
	0	0	0	0	0	120,000	930,000	740,000	350,000	490,000	WNW
	0	0	0	0	0	160,000	1.1×10^{6}	1.5×10^{6}	910,000	560,000	NW
	0	0	0	0	0	160,000	1.1×10^{6}	1.7×10^{6}	1.4×10^{6}	2.3×10^{6}	NNW

	Distance (miles)										
Food Type	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**	**Direction**
Grains (continued)	0	0	0	0	0	130,000	1.1×10^{6}	1.8×10^{6}	2.5×10^{6}	4.1×10^{6}	N
	0	0	0	0	0	98,000	1.1×10^{6}	1.8×10^{6}	2.7×10^{6}	3.6×10^{6}	NNE
	0	0	0	0	0	18,000	2.2×10^{6}	4.8×10^{6}	7.2×10^{6}	7.8×10^{6}	NE
	0	0	0	0	0	3,900	4.7×10^{6}	9.1×10^{6}	1.4×10^{7}	1.8×10^{7}	ENE
	0	0	0	0	0	200,000	4.7×10^{6}	9.8×10^{6}	1.6×10^{7}	1.8×10^{7}	E
	0	0	0	0	0	160,000	4.6×10^{6}	9.5×10^{6}	1.5×10^{7}	1.0×10^{7}	ESE
	0	0	0	0	0	0	4.4×10^{7}	1.1×10^{7}	1.4×10^{7}	1.7×10^{7}	SE
	0	0	0	0	0	0	1.2×10^{8}	1.0×10^{7}	1.4×10^{7}	1.6×10^{7}	SSE
Beef	0	0	0	0	0	0	210,000	490,000	730,000	960,000	S
	0	0	0	0	0	0	130,000	340,000	700,000	960,000	SSW
	0	0	0	0	0	2.2×10^{7}	320,000	250,000	480,000	620,000	SW
	0	0	0	0	0	1.7×10^{7}	2.0×10^{6}	250,000	380,000	760,000	WSW
	0	0	0	0	0	100,000	55,000	98,000	290,000	540,000	W
	0	0	0	0	0	100,000	92,000	49,000	90,000	160,000	WNW
	0	0	0	0	0	140,000	110,000	160,000	180,000	210,000	NW
	0	0	0	0	0	140,000	110,000	190,000	230,000	390,000	NNW
	0	0	0	0	0	120,000	110,000	190,000	300,000	610,000	N
	0	0	0	0	0	84,000	110,000	190,000	240,000	290,000	NNE
	0	0	0	0	0	1,800	86,000	310,000	490,000	570,000	NE
	0	0	0	0	0	23	28,000	290,000	830,000	1.1×10^{6}	ENE
	0	0	0	0	0	1,200	28,000	210,000	540,000	920,000	E
	0	0	0	0	0	950	28,000	120,000	380,000	410,000	ESE
	0	0	0	0	0	0	260,000	64,000	260,000	510,000	SE
	0	0	0	0	0	0	730,000	240,000	350,000	630,000	SSE
Poultry	0	0	0	0	0	0	0	0	0	26,000	S
	0	0	0	0	0	0	0	0	0	76,000	SSW
	0	0	0	0	0	1.7×10^{7}	0	0	0	17	SW
	0	0	0	0	0	1.4×10^{7}	1.6×10^{7}	0	22	310	WSW
	0	0	0	0	0	100,000	150,000	0	71	190	W
	0	0	0	0	0	100,000	710,000	0	0	300	WNW
	0	0	0	0	0	140,000	940,000	980,000	0	180,000	NW
	0	0	0	0	0	140,000	940,000	1.4×10^{6}	66,000	890,000	NNW
	0	0	0	0	0	120,000	940,000	1.6×10^{6}	1.9×10^{6}	3.1×10^{6}	N
	0	0	0	0	0	84,000	940,000	1.6×10^{6}	1.0×10^{6}	0	NNE
	0	0	0	0	0	15,000	640,000	970,000	660,000	0	NE
	0	0	0	0	0	0	0	0	0	0	ENE
	0	0	0	0	0	0	0	0	0	0	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Milk	0	0	0	0	0	0	480,000	540,000	650,000	800,000	S
	0	0	0	0	0	0	580,000	2.5×10^{6}	6.7×10^{6}	7.7×10^{6}	SSW
	0	0	0	0	0	1.1×10^{6}	640,000	1.1×10^{6}	4.3×10^{6}	4.0×10^{6}	SW
	0	0	0	0	0	980,000	1.7×10^{6}	1.1×10^{6}	1.7×10^{6}	4.2×10^{6}	WSW
	0	0	0	0	0	6,900	80,000	270,000	1.4×10^{6}	3.7×10^{6}	W
	0	0	0	0	0	6,700	48,000	0	0	810,000	WNW

	Distance (miles)										
Food Type	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**	**Direction**
Milk (continued)	0	0	0	0	0	9,100	63,000	370,000	1.4×10^6	1.0×10^6	NW
	0	0	0	0	0	9,200	64,000	250,000	2.0×10^6	3.8×10^6	NNW
	0	0	0	0	0	7,800	64,000	110,000	1.6×10^6	6.6×10^6	N
	0	0	0	0	0	5,700	64,000	110,000	470,000	960,000	NNE
	0	0	0	0	0	990	43,000	1.2×10^6	2.2×10^6	1.7×10^6	NE
	0	0	0	0	0	0	0	1.6×10^6	4.7×10^6	5.4×10^6	ENE
	0	0	0	0	0	0	0	1.6×10^6	4.2×10^6	5.7×10^6	E
	0	0	0	0	0	0	0	740,000	2.8×10^6	1.1×10^6	ESE
	0	0	0	0	0	0	14,000	12,000	56,000	110,000	SE
	0	0	0	0	0	0	150,000	180,000	260,000	310,000	SSE
Eggs	0	0	0	0	0	0	150,000	0	0	40,000	S
	0	0	0	0	0	0	0	0	0	120,000	SSW
	0	0	0	0	0	310,000	310,000	0	0	35	SW
	0	0	0	0	0	0	0	0	45	630	WSW
	0	0	0	0	0	0	0	0	140	380	W
	0	0	0	0	0	0	0	0	0	0	WNW
	0	0	0	0	0	0	0	87,000	390,000	220,000	NW
	0	0	0	0	0	0	0	44,000	570,000	570,000	NNW
	0	0	0	0	0	0	0	0	98,000	0	N
	0	0	0	0	0	0	0	0	0	0	NNE
	0	0	0	0	0	9.4	16,000	4,600	220	110	NE
	0	0	0	0	0	41	50,000	41,000	520	600	ENE
	0	0	0	0	0	2,200	50,000	38,000	110	470	E
	0	0	0	0	0	1,700	49,000	44,000	0	0	ESE
	0	0	0	0	0	0	330,000	1,900	0	0	SE
	0	0	0	0	0	0	480,000	0	0	0	SSE

kg/yr = kilogram per year
Source: HNUS 1996

Table D–17 Savannah River Site Meteorological Data (Joint Frequency Distributions) 1987-1991 at 61-m (201-ft) Height

Wind Speed (m/sec)	*Stability Class*	*Wind Blows Toward*															
		S	***SSW***	***SW***	***WSW***	***W***	***WNW***	***NW***	***NNW***	***N***	***NNE***	***NE***	***ENE***	***E***	***ESE***	***SE***	***SSE***
2	A	0.37	0.41	0.37	0.42	0.4	0.37	0.4	0.36	0.36	0.35	0.45	0.39	0.45	0.43	0.37	0.41
	B	0.08	0.08	0.09	0.1	0.05	0.06	0.06	0.05	0.08	0.07	0.05	0.05	0.05	0.08	0.05	0.07
	C	0.03	0.06	0.09	0.07	0.06	0.05	0.06	0.05	0.07	0.05	0.06	0.05	0.08	0.05	0.05	0.05
	D	0.02	0.05	0.06	0.04	0.06	0.03	0.06	0.07	0.06	0.03	0.07	0.05	0.04	0.03	0.05	0.04
	E	0.01	0.02	0.04	0.01	0.01	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.02
	F	0	0.01	0.01	0.01	0.01	0.01	0	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
4	A	0.87	0.74	0.88	1	0.94	0.94	0.65	0.62	0.74	0.72	1	1.28	1.29	0.94	0.53	0.6
	B	0.27	0.41	0.58	0.62	0.43	0.34	0.24	0.22	0.32	0.33	0.48	0.67	0.56	0.37	0.25	0.21
	C	0.17	0.57	1.13	1.03	0.6	0.41	0.41	0.37	0.48	0.52	0.59	0.79	0.53	0.45	0.3	0.24
	D	0.1	0.44	1.07	0.89	0.55	0.5	0.71	0.69	0.92	0.91	0.8	0.81	0.72	0.57	0.43	0.27
	E	0.06	0.27	0.69	0.48	0.3	0.33	0.46	0.7	0.67	0.57	0.54	0.47	0.43	0.43	0.33	0.3
	F	0.02	0.05	0.09	0.04	0.02	0.08	0.09	0.09	0.11	0.08	0.12	0.09	0.03	0.05	0.05	0.07
6	A	0.57	0.26	0.16	0.19	0.15	0.07	0.07	0.09	0.14	0.14	0.21	0.24	0.27	0.24	0.14	0.24
	B	0.14	0.39	0.38	0.31	0.16	0.11	0.07	0.08	0.19	0.21	0.32	0.51	0.51	0.36	0.13	0.09
	C	0.12	0.54	1.3	0.74	0.35	0.19	0.22	0.25	0.47	0.46	0.56	0.69	0.64	0.56	0.21	0.12
	D	0.12	0.43	0.85	0.58	0.4	0.44	0.65	1.16	1.45	0.78	0.9	0.77	0.78	0.65	0.32	0.09
	E	0.07	0.53	0.69	0.71	0.6	0.45	0.65	1.01	1.18	0.94	0.91	0.89	0.48	0.4	0.19	0.14
	F	0.01	0.26	0.21	0.14	0.14	0.19	0.13	0.16	0.22	0.21	0.24	0.23	0.07	0.04	0.02	0.04
8	A	0.09	0.05	0.01	0.01	0.01	0	0.01	0.01	0.02	0.02	0.02	0.04	0.03	0.02	0.01	0.06
	B	0.01	0.08	0.03	0.01	0.01	0.01	0	0.01	0.05	0.04	0.05	0.1	0.17	0.21	0.06	0.01
	C	0.01	0.1	0.2	0.08	0.02	0.03	0.03	0.06	0.16	0.16	0.21	0.26	0.45	0.43	0.1	0.02
	D	0.01	0.05	0.1	0.02	0.01	0.01	0.05	0.18	0.22	0.15	0.1	0.09	0.03	0.05	0.03	0
	E	0	0.05	0.03	0.04	0.01	0.01	0	0.03	0.04	0.02	0.04	0.01	0.01	0	0	0
	F	0	0.03	0.02	0.02	0	0.01	0	0.01	0.02	0.01	0.02	0.01	0	0	0	0
12	A	0.01	0	0	0	0	0	0	0	0	0.01	0.01	0.01	0	0.01	0	0.01
	B	0	0.01	0	0	0	0	0	0	0	0	0.01	0.01	0.06	0.06	0.01	0
	C	0	0.01	0	0	0	0.01	0	0.03	0.04	0.04	0.05	0.06	0.16	0.17	0.02	0.01
	D	0	0.02	0.02	0	0	0	0	0.01	0.02	0.04	0	0	0.01	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.1	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: WSRC 1996a.

D.1.3.3 Radiological Impact Assessments at Los Alamos National Laboratory

This section presents the radiological impact input data used in the assessment of the processing/storage alternatives at Los Alamos National Laboratory. For purposes of radiological impact modeling, Los Alamos National Laboratory analyses used the assumption that Technical Area 55 would be the location from which radioactive effluents would be released. **Table D–18** presents the characteristics of the release point, including location, release height, minimum distance, and annual average dispersion to the site boundary in each of 16 directions.

Table D–18 Release Point Characteristics, Direction, Distance, and Atmospheric Dispersion at the Los Alamos National Laboratory Site Boundary

Release Location	***Technical Area 55***	
Latitude	35.876°	
Longitude	-106.292°	
Release Height	11.2 m	
Distance and Atmospheric Dispersion at Site Boundary		
Direction	***Distance (m)***	***÷/Q (sec/m^3)***
N	1,000 [a]	2.5×10^{-6}
NNE	1,390	1.9×10^{-6}
NE	1,760	1.2×10^{-6}
ENE	2,800	4.8×10^{-7}
E	2,680	5.3×10^{-7}
ESE	1,680	9.6×10^{-7}
SE	6,420	1.1×10^{-7}
SSE	4,980	1.8×10^{-7}
S	3,350	3.7×10^{-7}
SSW	3,050	3.8×10^{-7}
SW	3,280	2.8×10^{-7}
WSW	3,430	2.0×10^{-7}
W	3,220	2.0×10^{-7}
WNW	2,600	2.1×10^{-7}
NW	2,000	3.4×10^{-7}
NNW	1,460	8.4×10^{-7}

÷/Q = Radioisotope concentrations divided by the rates at which they are emitted to the environment
sec/m^3 = second per cubic meter
[a] Nearest resident is present at this location (trailer court); this location is on private property that is surrounded by the site.
Source: LANL 1994, PNL 1988.

Descriptions of population and foodstuff distributions centered on Technical Area 55 are provided in **Table D–19** and **Table D–20**, respectively. The joint frequency distribution used for the dose assessment (presented in **Table D–21**) was based on the meteorological measurements for 1993 through 1996 from the meteorological tower at Los Alamos National Laboratory at the 11-m (36-ft) height.

Table D–19 Los Alamos National Laboratory Site Population Data Out to 80 km (50 mi) for Year 2000

	Distance (miles)										
Direction	***0-1***	***1-2***	***2-3***	***3-4***	***4-5***	***5-10***	***10-20***	***20-30***	***30-40***	***40-50***	***Total***
S	0	0	26	20	29	143	711	1,940	1,121	2,422	**6,412**
SSW	0	0	26	24	77	41	884	3,681	3,505	50,614	**58,852**
SW	0	0	26	22	76	114	51	1,237	856	10,074	**12,456**
WSW	0	0	26	32	96	317	256	1,065	1,784	43	**3,619**
W	0	0	47	78	117	163	201	682	85	531	**1,904**
WNW	0	507	65	89	116	195	63	123	2,293	393	**3,844**
NW	0	1,485	1,327	79	103	372	95	186	236	241	**4,124**
NNW	0	1,428	102	79	101	175	127	161	166	216	**2,555**
N	500	545	73	96	127	308	388	611	480	250	**3,378**
NNE	0	419	76	106	136	481	684	709	573	138	**3,322**
NE	0	521	76	95	66	419	5,769	3,046	1,348	2,425	**13,765**
ENE	0	717	142	24	20	275	17,189	3,811	3,049	2,436	**27,663**
E	0	543	415	15	20	444	4,970	774	764	1,105	**9,050**
ESE	0	119	31	15	20	171	1,045	3,520	396	659	**5,976**
SE	0	0	0	0	54	5,524	1,028	76,189	4,297	2,125	**89,217**
SSE	0	0	0	45	26	397	594	10,278	2,402	481	**14,223**
Total	**500**	**6,284**	**2,458**	**819**	**1,184**	**9,539**	**34,055**	**108,013**	**23,355**	**74,153**	**260,360**

Source: DOC 1992.

Table D–20 Los Alamos National Laboratory Site Agricultural Data (kg/yr)

	Distance/Miles										
Food Type	***0-1***	***1-2***	***2-3***	***3-4***	***4-5***	***5-10***	***10-20***	***20-30***	***30-40***	***40-50***	***Direction***
Leafy Veg.	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	0	0	0	WNW
	0	0	0	0	0	0	0	0	0	0	NW
	0	0	0	0	0	0	0	0	0	0	NNW
	0	0	0	0	0	0	0	0	0	0	N
	0	0	0	0	0	0	0	0	0	0	NNE
	0	0	0	0	0	0	0	0	0	0	NE
	0	0	0	0	0	0	0	0	0	0	ENE
	0	0	0	0	0	0	0	0	0	0	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Root Veg.	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	0	0	0	WNW
	0	0	0	0	0	0	0	0	0	0	NW
	0	0	0	0	0	0	0	0	0	0	NNW
	0	0	0	0	0	0	0	0	0	0	N
	0	0	0	0	0	0	0	0	0	0	NNE

	Distance/Miles										
Food Type	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**	**Direction**
Root Veg. (continued)	0	0	0	0	0	0	0	0	0	0	NE
	0	0	0	0	0	0	0	0	0	0	ENE
	0	0	0	0	0	0	0	0	0	0	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Fruits	0	0	0	110	290	3,100	9,.600	12,000	15,000	17,000	S
	0	0	55.0	290	380	3,100	13,000	21,000	29,000	35,000	SSW
	0	0	39.0	290	360	3,100	13,000	21,000	29,000	38,000	SW
	0	0	0	50.0	45.0	2,300	13,000	21,000	29,000	38,000	WSW
	0	0	0	0	0	2,700	13,000	21,000	29,000	38,000	W
	0	0	0	0	0	2,600	13,000	22,000	31,000	38,000	WNW
	0	0	0	0	0	1,700	14,000	24,000	34,000	43,000	NW
	0	0	0	0	0	2,000	15,000	24,000	34,000	44,000	NNW
	0	0	0	0	0	2,100	15,000	24,000	34,000	44,000	N
	0	0	0	0	0	2,300	15,000	24,000	33,000	41,000	NNE
	0	0	0	7.70	38.0	3,200	15,000	24,000	15,000	680	NE
	0	0	4.50	42.0	57.0	1,200	9,900	21,000	23,000	1,100	ENE
	0	0	16.0	44.0	57.0	470	1,900	3,200	8,000	5,400	E
	0	0	13.0	44.0	57.0	440	1,900	3,200	2,000	290	ESE
	0	0	0	0	17.0	280	1,900	3,200	4,200	2,000	SE
	0	0	0	0	0	470	1,900	3,200	4,400	5,700	SSE
Grains	0	0	0	84.0	210	2,300	8,700	14,000	19,000	30,000	S
	0	0	40.0	220	280	2,300	9,200	15,000	22,000	35,000	SSW
	0	0	29.0	210	270	2,300	9,200	15,000	22,000	28,000	SW
	0	0	0	37.0	33.0	1,700	9,200	15,000	22,000	28,000	WSW
	0	0	0	0	0	2,000	9,200	15,000	22,000	28,000	W
	0	0	0	0	0	1,900	9,200	13,000	18,000	28,000	WNW
	0	0	0	0	0	1,200	5,900	5,100	8,000	13,000	NW
	0	0	0	0	0	1,500	3,400	5,100	7,100	9,200	NNW
	0	0	0	0	0	1,300	3,100	5,100	7,100	9,200	N
	0	0	0	0	0	880	3,100	5,100	6,900	8,700	NNE
	0	0	0	30.0	150	900	3,100	5,100	4,400	3,000	NE
	0	0	18.0	170	220	1,600	4,700	6,400	5,500	3,100	ENE
	0	0	61.0	170	220	1,900	7,500	12,000	9,400	7,400	E
	0	0	50.0	170	220	1,700	7,500	12,000	17,000	22,000	ESE
	0	0	0	0	69.0	1,100	7,500	12,000	17,000	22,000	SE
	0	0	0	0	0	1,200	7,500	12,000	17,000	22,000	SSE
Beef	0	0	0	0	0	38.0	58,000	170,000	280,000	510,000	S
	0	0	0	0	0	0	0	0	0	190,000	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	85,000	110,000	0	WNW
	0	0	0	0	0	0	110,000	330,000	430,000	460,000	NW
	0	0	0	0	0	270	190,000	330,000	460,000	590,000	NNW
	0	0	0	0	0	7,100	200,000	330,000	460,000	590,000	N
	0	0	0	0	0	20,000	200,000	330,000	450,000	570,000	NNE
	0	0	0	850	4,200	49,000	200,000	330,000	360,000	370,000	NE
	0	0	500	4,700	6,300	52,000	200,000	330,000	400,000	370,000	ENE
	0	0	1,700	4,900	6,300	52,000	210,000	350,000	690,000	970,000	E
	0	0	1,400	4,900	6,300	48,000	210,000	350,000	740,000	1.20×10^{6}	ESE
	0	0	0	0	1,900	31,000	210,000	350,000	510,000	1.00×10^{6}	SE
	0	0	0	0	0	30,000	210,000	350,000	490,000	630,000	SSE

	Distance/Miles										
Food Type	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**	**Direction**
Poultry	0	0	0	0	0	0	0	0	0	0	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	0	0	0	WNW
	0	0	0	0	0	0	0	0	0	0	NW
	0	0	0	0	0	0	0	0	0	0	NNW
	0	0	0	0	0	0	0	0	0	0	N
	0	0	0	0	0	0	0	0	0	0	NNE
	0	0	0	0	0	0	0	0	0	0	NE
	0	0	0	0	0	0	0	0	0	0	ENE
	0	0	0	0	0	0	0	0	0	0	E
	0	0	0	0	0	0	0	0	0	0	ESE
	0	0	0	0	0	0	0	0	0	0	SE
	0	0	0	0	0	0	0	0	0	0	SSE
Milk	0	0	0	0	0	4.1	6,100	18,000	29,000	1.20×10^{6}	S
	0	0	0	0	0	0	0	0	0	1.50×10^{6}	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	3,100	4,000	0	WNW
	0	0	0	0	0	0	3,900	12,000	16,000	16,000	NW
	0	0	0	0	0	9.80	6,700	12,000	17,000	21,000	NNW
	0	0	0	0	0	260	7,100	12,000	17,000	21,000	N
	0	0	0	0	0	720	7,100	12,000	16,000	21,000	NNE
	0	0	0	90.0	440	2,300	7,100	12,000	13,000	13,000	NE
	0	0	53.0	490	670	4,700	13,000	16,000	14,000	13,000	ENE
	0	0	180	520	670	5,.600	22,000	37,000	37,000	43,000	E
	0	0	150	520	670	5,100	22,000	37,000	35,000	28,000	ESE
	0	0	0	0	200	3,300	22,000	37,000	50,000	41,000	SE
	0	0	0	0	0	3,200	22,000	37,000	52,000	67,000	SSE
Eggs	0	0	0	0	0	0.0770	120	340	550	750	S
	0	0	0	0	0	0	0	0	0	0	SSW
	0	0	0	0	0	0	0	0	0	0	SW
	0	0	0	0	0	0	0	0	0	0	WSW
	0	0	0	0	0	0	0	0	0	0	W
	0	0	0	0	0	0	0	70.0	91.0	0	WNW
	0	0	0	0	0	0	89.0	270	360	380	NW
	0	0	0	0	0	22.0	150	270	380	490	NNW
	0	0	0	0	0	5.90	160	270	380	490	N
	0	0	0	0	0	17.0	160	270	360	450	NNE
	0	0	0	1.70	8.40	49.0	160	270	160	57.0	NE
	0	0	1.00	9.40	13.0	91.0	260	350	250	5.40	ENE
	0	0	3.50	9.90	13.0	110	420	700	430	240	E
	0	0	2.80	9.90	13.0	97.0	420	700	720	680	ESE
	0	0	0	0	3.80	63.0	420	700	960	860	SE
	0	0	0	0	0	60.0	420	700	990	1,300	SSE

kg/yr = kilogram per year
Source: DOC 1993.

Table D–21 Los Alamos National Laboratory 1993-1996 Joint Frequency Distributions at 11-m (36-ft) Height

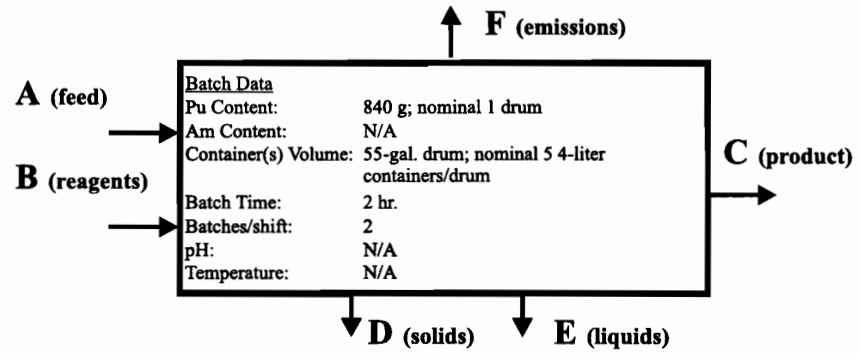
Wind Speed (m/sec)	*Stability Class*	*Wind Blows Toward*															
		S	***SSW***	***SW***	***WSW***	***W***	***WNW***	***NW***	***NNW***	***N***	***NNE***	***NE***	***ENE***	***E***	***ESE***	***SE***	***SSE***
0.78	A	0.12	0.26	0.5	0.84	0.74	0.54	0.45	0.32	0.18	0.11	0.08	0.05	0.06	0.06	0.07	0.07
	B	0.03	0.05	0.12	0.19	0.16	0.09	0.08	0.07	0.04	0.01	0.02	0.01	0.02	0.02	0.01	0.02
	C	0.05	0.09	0.14	0.2	0.16	0.09	0.09	0.09	0.07	0.04	0.03	0.03	0.02	0.03	0.02	0.03
	D	0.86	0.69	0.57	0.45	0.47	0.34	0.33	0.33	0.38	0.35	0.33	0.31	0.35	0.4	0.57	0.72
	E	0.59	0.45	0.33	0.23	0.22	0.15	0.13	0.13	0.17	0.24	0.32	0.28	0.29	0.4	0.51	0.62
	F	0.26	0.28	0.27	0.19	0.18	0.17	0.2	0.25	0.3	0.32	0.22	0.17	0.15	0.2	0.24	0.25
2.5	A	0.03	0.07	0.17	0.45	0.56	0.43	0.33	0.22	0.18	0.08	0.06	0.05	0.04	0.03	0.03	0.03
	B	0.02	0.05	0.2	0.39	0.42	0.31	0.27	0.22	0.16	0.1	0.06	0.05	0.05	0.04	0.03	0.02
	C	0.05	0.15	0.46	0.68	0.65	0.45	0.46	0.59	0.59	0.26	0.16	0.12	0.16	0.12	0.07	0.05
	D	0.95	1.09	0.94	0.72	0.56	0.34	0.47	1.3	2.12	1.89	1.93	0.95	1.08	0.81	0.56	0.63
	E	0.87	0.59	0.34	0.19	0.11	0.1	0.13	0.24	0.67	1.82	2.41	1.72	1.84	1.41	0.8	0.8
	F	0.09	0.07	0.05	0.03	0.01	0.01	0.05	0.1	0.25	0.33	0.11	0.36	0.39	0.39	0.12	0.07
4.5	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.01	0.02	0.01	0
	C	0.02	0.04	0.07	0.04	0.02	0.01	0.01	0.03	0.15	0.09	0.11	0.19	0.31	0.19	0.09	0.02
	D	0.81	0.8	0.42	0.16	0.07	0.04	0.11	0.99	3.24	3.52	2.59	1.61	1.86	1.05	0.54	0.44
	E	0.21	0.2	0.08	0.01	0	0	0.01	0.07	0.32	1.74	1.08	1.32	1.31	0.32	0.23	0.22
	F	0	0.01	0	0	0	0	0	0	0.02	0.04	0	0.05	0.05	0.01	0.01	0
6.9	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.01	0	0
	D	0.19	0.2	0.05	0	0	0	0.01	0.31	0.96	1.42	0.87	0.93	0.62	0.48	0.31	0.15
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.6	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0.01	0.01	0	0	0	0	0	0.05	0.03	0.08	0.09	0.19	0.08	0.05	0.04	0.02
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0.01	0	0	0.01	0.01	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: LANL 1997.

D.1.4 Sample Batch Flow Diagrams and Supplemental Data

This section contains a sample "process alternative" batch data summary for Rocky Flats (vitrification of ash). Included are a process description, personnel radiation exposure estimates, operations requirements, and input/output diagrams. A separate Technical Report (SAIC 1998a) includes all batch data summaries (i.e., technology descriptions) for all processing alternatives at each site examined in this EIS.

Drum Unloading/Bag-In



Total Components	A	B	C	D	E	F
Pu (kg)	1,164		1,164			<1E-12
Am						
Residue Matrix (kg)	20,057		20,057			
Water/Acid						
Other						
No. of containers in drums	6,400		6,400			
No. of drums	1,280			1,280		
No. of other containers	530		530			
Total No. of containers			6,930			

Radiation levels: - 14 mrem/hr whole body on contact
- 1.37 mrem/hr whole body (Background & 6' from source)

Operations Data

Workstations:
- Transportation
- Contam. Cntrl. Enclosure
- Bag-in at glovebox
-

Staffing:
- 3 shifts/day; 5 days/week
- 3 Operators at unit
- 0.5 hours/shift in gloves
- 14 Opr. exp. dose rate in gloves
- 5 Total personnel at unit
- 2 hours/shift in area
- 1.37 Exp. dose rate

Batches/week: 2x8=16 (RAM factor)

Special Requirements: - None

Process Data

Equipment:
- Contam. Cntrl. Enclosure
- Hand tools
- Glovebox bag-in
- Drum Handling Equip.

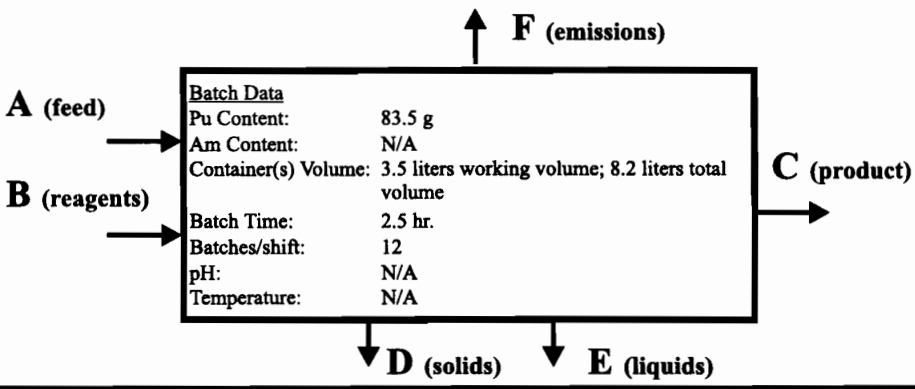
Space Requirements: - 2250 ft²

Utilities:
- No Electricity
- No Water
- No Air
- No Steam
- No Other
- No Other

Location: - Building 707, Modules D/E

New Equipment Cost: - $0K

Feed Preparation



Total Components	A	B	C	D	E	F
Pu (kg)	1,164		1,152	12		1E-8
Am						
Residue Matrix (kg)	20,057			207		
Residue and Frit Matrix (kg)			39,700			
Water/Acid						
Glass Frit (kg)		19,850				
No. of 8.2 liter containers		13,800	13,800			
No. 4 liter/other feed containers	6,930			6,930		
No. of Batches	6,930		13,800			

Radiation levels: - 0 mrem/hr whole body on contact
- 0.5 mrem/hr whole body (Background & 6' from source)

Operations Data

Workstations:
- Sort
- Crush
- Sieve/Batch/Blend
- Trash Removal

Process Data

Equipment:
- Crusher
- Rototap/Sieves
- Scales
- Gram Estimator
- Blender
- Glovebox Bag-out

Staffing:
- 3 shifts/day; 5 days/week
- 4 Operators at unit
- 3 hours/shift in gloves
- 0 Opr. exp. dose rate in gloves
- 6 Total personnel at unit
- 6 hours/shift in area
- 0.5 Exp. dose rate

Space Requirements: - 360 ft² (glovebox)

Utilities:
- Yes Electricity
- No Water
- No Air
- No Steam
- No Other
- No Other

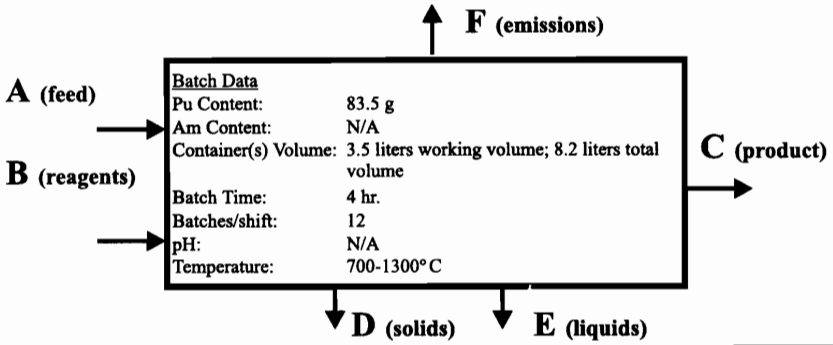
Batches/week: - 12x8=96 (RAM factor)

Location: - Building 707, Module E

Special Requirements: - None

New Equipment Cost: - $0K

Vitrification



Total Components	A	B	C	D	E	F
Pu (kg)	1,152		1,152			1E-8
Am (kg)						
Residue + Frit (kg)	39,700		34,500			
Water/Acid (liters)						
Scrubber K_2CO_3 (kg)		397		397		
No. of 8.2-liter containers	13,800		13,800			
No. of convenience cans		13,800	13,800			
Nominal Carbon (kg) (as CO_2)						5,200 (19,100)

Radiation levels: - 15 mrem/hr whole body on contact
- 0.6 mrem/hr whole body (Background & 6' from source)

Operations Data

Workstations:
- Furnace Load/Unload
- Cooling/Staging/Weighing
- Sealing/Taping Can
- Bag-out at Glovebox
- Convenience Canning

Process Data

Equipment:
- Furnace (6)
- Solid-phase Scrubber (6)
- Heat Exchanger (6)
- Scale
- Glovebox Bag-out

Staffing:
- 3 shifts/day; 5 days/week
- 3 Operators at unit
- 0.5 hours/shift in gloves
- 1.5 Opr. exp. dose rate in gloves
- 5 Total personnel at unit
- 6 hours/shift in area
- 0.6 Exp. dose rate

Space Requirements: - 480 ft² (glovebox)

Utilities:
- Yes Electricity
- No Water
- Yes Air
- No Steam
- Yes Other
- Yes Other

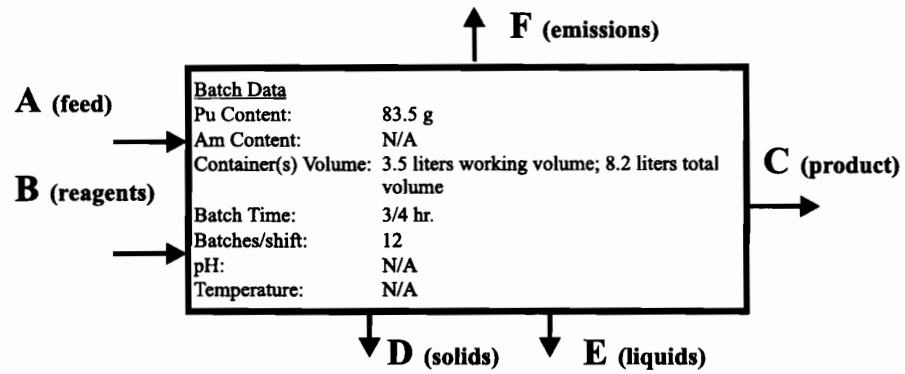
Batches/week: - 12x8=96 (RAM factor)

Location: - Building 707, Module E

Special Requirements: - None

New Equipment Cost: - $100K

NDA



Total Components	A	B	C	D	E	F
Pu (kg)	1,152		1,152			<1E-12
Am (kg)						
Residue + Frit (kg)	34,500		34,500			
Water/Acid (liters)						
No. of 8.2-liter containers	13,800		13,800			
No. of convenience cans	13,800		13,800			

Radiation levels: - 1.5 mrem/hr whole body on contact
- 0.6 mrem/hr whole body (Background & 6' from source)

Operations Data

Workstations:
- NDA
- Transportation
-
-

Process Data

Equipment:
- Segmented Gamma Scanner
- Carts
-

Staffing:
- 3 shifts/day; 5 days/week
- 2 Operators at unit
- 1 hours/shift in gloves
- 1.5 Opr. exp. dose rate in gloves
- 3 Total personnel at unit
- 6 hours/shift in area
- 0.6 Sppt. exp. dose rate

Space Requirements: - No gloveboxes

Utilities:
- Yes Electricity
- No Water
- No Air
- No Steam
- No Other
- No Other

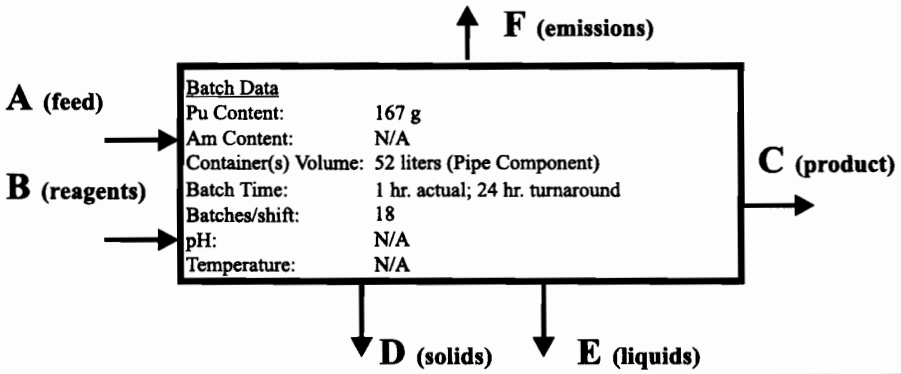
Batches/week: - 12x8=96 (RAM factor)

Location: - Building 707, Module E

Special Requirements: - None

New Equipment Cost: - $300-600K

Final Drum Packaging and Storage



Total Components	A	B	C	D	E	F
Pu (kg)	1,152		1,152			<1E-12
Am (kg)						
Residue + Frit (kg)	34,500		34,500			
Water/Acid (liters)						
No. of 8.2-liter containers	13,800		13,800			
No. of convenience cans	13,800		13,800			
No. of Pipe Components		6,900	6,900			
No. of drums w/Celetex		6,900	6,900			

Radiation levels: - 1.5 mrem/hr whole body on contact
- 0.6 mrem/hr whole body (Background & 6' from source)

Operations Data

Workstations:
- Drum Packaging
- Transportation
- Storage

Process Data

Equipment:
- Drum Moving Equip.
-
-

Staffing:
- 1 shifts/day; 5 days/week
- 2 Operators at unit
- 1 hours/shift in gloves
- 1.5 Opr. exp. dose rate in gloves
- 4 Total personnel at unit
- 6 hours/shift in area
- 0.6 Exp. dose rate

Space Requirements: - No gloveboxes

Utilities:
- No Electricity
- No Water
- No Air
- No Steam
- No Other
- No Other

Batches/week: 18x3=54 (RAM factor)

Location: - Various

Special Requirements: - None

New Equipment Cost: - $0K

D.2 NORMAL OPERATIONAL RADIOLOGICAL RELEASES AND IMPACTS TO THE ENVIRONMENT

This section presents compilations of radiological releases to the environment as well as resulting impact ranges from processes associated with all alternatives assessed in this EIS. The total releases of radioactivity to the environment associated with processes common to processing/storage activities are given in **Table D–22**. The releases, by radionuclide, include those for applicable operations at each site in question and differ according to site location and were based on information given in detailed technical descriptions of all the process options assessed in the EIS. These descriptions were supplied by each of the sites being addressed in the EIS.

For processing at Rocky Flats or Los Alamos National Laboratory, the amounts of plutonium and americium released to the environment, in mass units, were based on an analysis of each processing step in the glove box to determine the amounts of plutonium and americium present in each of these steps. For those steps that involve actions with unsealed material, one tenth of one percent of this material was assumed to get into the glove box atmosphere. The exhaust from the glove box would then pass through four sets of High-Efficiency Particulate Air filters in series, each assumed to have a reduction factor of 100 (99% efficient), before being released to the outside atmosphere.

The isotopic composition of the plutonium and americium released to the atmosphere was based on a document titled "Rocky Flats Calculation 95-SAE-002", January 3, 1996. (RF 1996) This composition is given in Table D–23, which provides the conversion of mass units to curies. The distribution of plutonium and americium radionuclides accounts for changes that have taken place over the storage period due to decay and growth of americium-241. The additional amount of americium for salt residues (noted in a footnote to the table) accounts for the higher amounts of americium present in salt residues and scrub alloy than in the other residues.

For processing at the Savannah River Site, the releases from the canyons to the atmosphere are based on operating experience with similar materials. The releases were adjusted to account for the specific throughputs of materials assessed in the EIS.

Tables D-24 through **D-26** present the maximum impacts associated with each site. These tables are provided to illustrate the largest possible incident-free impacts associated with each residue type that could exist at each site for all possible alternatives examined in this EIS. The detailed results of the impact assessments are given in Chapter 4 of this EIS.

Table D–22 Total Radioactive Releases During Normal Operation of Processing/Storage Processes (Ci) [a]

Process Radionuclides	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Calcining/Cementation of Ash			
Plutonium 238	2.2×10^{-7}	—	—
Plutonium 239	2.5×10^{-6}	—	—
Plutonium 240	5.6×10^{-7}	—	—
Plutonium 241	0.000015	—	—
Plutonium 242	5.2×10^{-11}	—	—
Americium 241	2.6×10^{-8}	—	—
Immobilization (Calcination/Vitrification) of Ash			
Plutonium 238	1.0×10^{-7}	—	—
Plutonium 239	1.2×10^{-6}	—	—
Plutonium 240	2.6×10^{-7}	—	—
Plutonium 241	6.9×10^{-6}	—	—
Plutonium 242	2.4×10^{-11}	—	—

Process Radionuclides	Rocky Flats	Savannah River Site	Los Alamos National Laboratory
Americium 241	1.2×10^{-8}	—	—
Cold Ceramification of Incinerator Ash			
Plutonium 238	1.2×10^{-7}	—	—
Plutonium 239	1.3×10^{-6}	—	—
Plutonium 240	3.0×10^{-7}	—	—
Plutonium 241	7.8×10^{-6}	—	—
Plutonium 242	2.8×10^{-11}	—	—
Americium 241	1.4×10^{-8}	—	—
Blend Down of Ash			
Plutonium 238	1.7×10^{-7}	—	—
Plutonium 239	2.0×10^{-6}	—	—
Plutonium 240	4.4×10^{-7}	—	—
Plutonium 241	0.000011	—	—
Plutonium 242	4.1×10^{-11}	—	—
Americium 241	2.0×10^{-8}	—	—
Preprocess Ash at Rocky Flats for Transport to the Savannah River Site (for Mediated Electrochemical Oxidation at the Savannah River Site)			
Plutonium 238	1.5×10^{-7}	—	—
Plutonium 239	1.7×10^{-6}	—	—
Plutonium 240	3.8×10^{-7}	—	—
Plutonium 241	0.000010	—	—
Plutonium 242	3.6×10^{-11}	—	—
Americium 241	1.8×10^{-8}	—	—
Preprocess Ash at Rocky Flats for Transport to the Savannah River Site (for Purex at the Savannah River Site)			
Plutonium 238	1.5×10^{-7}	—	—
Plutonium 239	1.7×10^{-6}	—	—
Plutonium 240	3.8×10^{-7}	—	—
Plutonium 241	0.000010	—	—
Plutonium 242	3.6×10^{-11}	—	—
Americium 241	1.8×10^{-8}	—	—
Sand, Slag, and Crucible Purex Process—Rocky Flats Size Reduced			
Plutonium 238	—	0.000025	—
Plutonium 239	—	0.000026	—
Americium 241/243	—	0.000017	—
Fusion/Purex Process for Ash			
Plutonium 238	—	0.00029	—
Plutonium 239	—	0.00031	—
Americium 241/243	—	0.00020	—
Mediated Electrochemical Oxidation for Ash			
Plutonium 238	—	0.00017	—
Plutonium 239	—	0.00018	—
Americium 241/243	—	0.00012	—
Repackage for Ash			
Plutonium 238	5.9×10^{-8}	—	—
Plutonium 239	6.8×10^{-7}	—	—
Plutonium 240	1.6×10^{-7}	—	—
Plutonium 241	3.9×10^{-6}	—	—
Plutonium 242	1.4×10^{-11}	—	—
Americium 241	7.0×10^{-9}	—	—
Pyro-oxidation of Salts			
Plutonium 238	1.0×10^{-7}	—	—
Plutonium 239	1.2×10^{-6}	—	—

Process Radionuclides	Rocky Flats	Savannah River Site	Los Alamos National Laboratory
Plutonium 240	2.6×10^{-7}	—	—
Plutonium 241	6.8×10^{-6}	—	—
Plutonium 242	2.4×10^{-11}	—	—
Americium 241	3.5×10^{-7}	—	—
Pyro-oxidation/Blend Down of Salts			
Plutonium 238	2.5×10^{-7}	—	—
Plutonium 239	2.9×10^{-6}	—	—
Plutonium 240	6.4×10^{-7}	—	—
Plutonium 241	0.000017	—	—
Plutonium 242	6.0×10^{-11}	—	—
Americium 241	8.8×10^{-7}	—	—
Salt Scrub for Pyro Salts/Ship Scrub Alloy to the Savannah River Site			
Plutonium 238	1.5×10^{-7}	—	—
Plutonium 239	1.7×10^{-6}	—	—
Plutonium 240	3.9×10^{-7}	—	—
Plutonium 241	0.000010	—	—
Plutonium 242	3.6×10^{-11}	—	—
Americium 241	4.9×10^{-7}	—	—
Preprocess Salt Residues at Rocky Flats for Transport to Los Alamos National Laboratory (All Salts)			
Plutonium 238	1.1×10^{-7}	—	—
Plutonium 239	1.3×10^{-6}	—	—
Plutonium 240	2.9×10^{-7}	—	—
Plutonium 241	7.4×10^{-6}	—	—
Plutonium 242	2.6×10^{-11}	—	—
Americium 241	3.7×10^{-7}	—	—
Salt Distillation (MSE/ER Salts)			
Plutonium 238	1.8×10^{-7}	—	4.3×10^{-8}
Plutonium 239	2.0×10^{-6}	—	5.0×10^{-7}
Plutonium 240	4.5×10^{-7}	—	1.1×10^{-7}
Plutonium 241	0.000012	—	2.9×10^{-6}
Plutonium 242	4.2×10^{-11}	—	1.0×10^{-11}
Americium 241	2.9×10^{-7}	—	7.3×10^{-8}
Dissolution of Salt Residues from Plutonium Oxide (Water Leach) - (All Salts at Rocky Flats; DOR Salts Only at LANL)			
Plutonium 238	3.7×10^{-7}	—	9.4×10^{-9}
Plutonium 239	4.3×10^{-6}	—	1.1×10^{-7}
Plutonium 240	9.7×10^{-8}	—	2.4×10^{-8}
Plutonium 241	0.000025	—	6.3×10^{-7}
Plutonium 242	8.9×10^{-11}	—	2.2×10^{-12}
Americium 241	1.3×10^{-6}	—	1.1×10^{-7}
Preprocess Salt Residues at Rocky Flats for Transport to Los Alamos National Laboratory (MSE/ER Salt-IDC 409 only)			
Plutonium 238	2.4×10^{-8}	—	—
Plutonium 239	2.7×10^{-7}	—	—
Plutonium 240	6.1×10^{-8}	—	—
Plutonium 241	1.6×10^{-6}	—	—
Plutonium 242	5.6×10^{-12}	—	—
Americium 241	2.8×10^{-9}	—	—
Salt Distillation (MSE/ER Salt-IDC 409 only)			
Plutonium 238	—	—	2.3×10^{-8}
Plutonium 239	—	—	2.7×10^{-7}
Plutonium 240	—	—	6.1×10^{-8}
Plutonium 241	—	—	1.6×10^{-6}
Plutonium 242	—	—	5.6×10^{-12}

Process Radionuclides	Rocky Flats	Savannah River Site	Los Alamos National Laboratory
Americium 241	—	—	2.8×10^{-9}
Preprocess Salt Residues at Rocky Flats for Transport to Los Alamos National Laboratory (DOR Salts-IDCs 365, 413, and 427			
Plutonium 238	1.4×10^{-8}	—	—
Plutonium 239	1.6×10^{-7}	—	—
Plutonium 240	3.6×10^{-8}	—	—
Plutonium 241	9.5×10^{-7}	—	—
Plutonium 242	3.4×10^{-12}	—	—
Americium 241	2.1×10^{-7}	—	—
Acid Dissolution (DOR Salts-IDC's 365, 413, and 427			
Plutonium 238	—	—	3.5×10^{-8}
Plutonium 239	—	—	4.0×10^{-7}
Plutonium 240	—	—	9.0×10^{-8}
Plutonium 241	—	—	2.3×10^{-6}
Plutonium 242	—	—	8.3×10^{-12}
Americium 241	—	—	5.0×10^{-7}
Repackage of Salts			
Plutonium 238	1.4×10^{-7}	—	—
Plutonium 239	1.6×10^{-6}	—	—
Plutonium 240	3.6×10^{-7}	—	—
Plutonium 241	9.3×10^{-6}	—	—
Plutonium 242	3.3×10^{-11}	—	—
Americium 241	5.1×10^{-7}	—	—
Neutralize/Dry (Aqueous) Combustibles			
Plutonium 238	1.6×10^{-9}	—	—
Plutonium 239	1.6×10^{-8}	—	—
Plutonium 240	3.9×10^{-9}	—	—
Plutonium 241	9.5×10^{-8}	—	—
Plutonium 242	3.4×10^{-13}	—	—
Americium 241	1.7×10^{-10}	—	—
Thermal Desorption/Steam Passivation (Organic) Combustibles			
Plutonium 238	1.0×10^{-9}	—	—
Plutonium 239	1.2×10^{-8}	—	—
Plutonium 240	2.6×10^{-9}	—	—
Plutonium 241	6.8×10^{-8}	—	—
Plutonium 242	2.4×10^{-13}	—	—
Americium 241	1.2×10^{-10}	—	—
Repackage (Dry Combustibles)			
Plutonium 238	5.5×10^{-10}	—	—
Plutonium 239	6.0×10^{-9}	—	—
Plutonium 240	1.0×10^{-9}	—	—
Plutonium 241	3.7×10^{-8}	—	—
Plutonium 242	1.3×10^{-13}	—	—
Americium 241	6.6×10^{-11}	—	—
Sonic Wash (Aqueous, Organic, and Dry Combustibles)			
Plutonium 238	5.0×10^{-9}	—	—
Plutonium 239	5.8×10^{-8}	—	—
Plutonium 240	1.3×10^{-8}	—	—
Plutonium 241	3.4×10^{-7}	—	—
Plutonium 242	1.2×10^{-12}	—	—
Americium 241	6.0×10^{-10}	—	—
Digestion (Aqueous, Organic, and Dry Combustibles)			

Process Radionuclides	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Plutonium 238	3.2×10^{-9}	—	—
Plutonium 239	3.7×10^{-8}	—	—
Plutonium 240	8.4×10^{-9}	—	—
Plutonium 241	2.2×10^{-7}	—	—
Plutonium 242	7.7×10^{-13}	—	—
Americium 241	3.9×10^{-10}	—	—
Blend Down (Aqueous, Organic, and Dry Combustibles)			
Plutonium 238	2.0×10^{-9}	—	—
Plutonium 239	2.5×10^{-8}	—	—
Plutonium 240	6.0×10^{-9}	—	—
Plutonium 241	1.4×10^{-7}	—	—
Plutonium 242	5.2×10^{-13}	—	—
Americium 241	2.6×10^{-10}	—	—
Mediated Electrochemical Oxidation for Aqueous/Organic-Contaminated and Dry Combustibles			
Plutonium 238	5.2×10^{-9}	—	—
Plutonium 239	6.0×10^{-8}	—	—
Plutonium 240	1.4×10^{-8}	—	—
Plutonium 241	3.5×10^{-7}	—	—
Plutonium 242	1.2×10^{-12}	—	—
Americium 241	6.2×10^{-10}	—	—
Acid Dissolution/Plutonium Oxide Recovery for Plutonium Fluorides			
Plutonium 238	3.6×10^{-8}	—	—
Plutonium 239	4.1×10^{-7}	—	—
Plutonium 240	9.1×10^{-8}	—	—
Plutonium 241	2.4×10^{-6}	—	—
Plutonium 242	8.5×10^{-12}	—	—
Americium 241	4.8×10^{-9}	—	—
Blend Down of Plutonium Fluorides			
Plutonium 238	N/E	—	—
Plutonium 239	N/E	—	—
Plutonium 240	N/E	—	—
Plutonium 241	N/E	—	—
Plutonium 242	N/E	—	—
Americium 241	N/E	—	—
Preprocess Plutonium Fluorides at Rocky Flats for Shipment to the Savannah River Site			
Plutonium 238	7.5×10^{-9}	—	—
Plutonium 239	8.1×10^{-8}	—	—
Plutonium 240	1.8×10^{-8}	—	—
Plutonium 241	4.7×10^{-7}	—	—
Plutonium 242	1.7×10^{-12}	—	—
Americium 241	8.4×10^{-10}	—	—
Fluorides Purex Process			
Plutonium 238	—	0.000038	—
Plutonium 239	—	0.000041	—
Americium 241/243	—	0.000027	—
Neutralize/Dry All Filter Media			
Plutonium 238	1.7×10^{-8}	—	—
Plutonium 239	1.9×10^{-7}	—	—
Plutonium 240	4.3×10^{-8}	—	—
Plutonium 241	1.1×10^{-6}	—	—
Plutonium 242	4.0×10^{-12}	—	—
Americium 241	2.0×10^{-9}	—	—

Process Radionuclides	Rocky Flats	Savannah River Site	Los Alamos National Laboratory
Neutralize/Dry Filter Media (IDC's 331 and 338 only)			
Plutonium 238	1.6×10^{-8}	—	—
Plutonium 239	1.9×10^{-7}	—	—
Plutonium 240	4.3×10^{-8}	—	—
Plutonium 241	1.1×10^{-6}	—	—
Plutonium 242	4.0×10^{-12}	—	—
Americium 241	2.0×10^{-9}	—	—
Immobilization (Vitrification) of High-Efficiency Particulate Air Filter Media			
Plutonium 238	1.0×10^{-8}	—	—
Plutonium 239	1.2×10^{-7}	—	—
Plutonium 240	2.6×10^{-8}	—	—
Plutonium 241	6.7×10^{-7}	—	—
Plutonium 242	2.4×10^{-12}	—	—
Americium 241	1.0×10^{-9}	—	—
Blend Down Filter Media			
Plutonium 238	1.1×10^{-8}	—	—
Plutonium 239	1.3×10^{-7}	—	—
Plutonium 240	2.8×10^{-8}	—	—
Plutonium 241	7.3×10^{-7}	—	—
Plutonium 242	2.6×10^{-12}	—	—
Americium 241	1.0×10^{-9}	—	—
Sonic Wash of Filter Media			
Plutonium 238	2.3×10^{-8}		
Plutonium 239	2.6×10^{-7}	—	—
Plutonium 240	5.9×10^{-8}	—	—
Plutonium 241	1.5×10^{-6}	—	—
Plutonium 242	5.5×10^{-12}	—	—
Americium 241	3.0×10^{-9}	—	—
Mediated Electrochemical Oxidation for Filter Media			
Plutonium 238	2.2×10^{-8}	—	—
Plutonium 239	2.5×10^{-7}	—	—
Plutonium 240	5.7×10^{-8}	—	—
Plutonium 241	1.5×10^{-6}	—	—
Plutonium 242	5.2×10^{-12}	—	—
Americium 241	2.6×10^{-9}	—	—
Repackage of HEPA Filters (All IDC's except 338)			
Plutonium 238	1.0×10^{-10}	—	—
Plutonium 239	1.2×10^{-9}	—	—
Plutonium 240	2.7×10^{-10}	—	—
Plutonium 241	6.9×10^{-9}	—	—
Plutonium 242	2.4×10^{-14}	—	—
Americium 241	1.2×10^{-11}	—	—
Filter/Dry Sludges			
Plutonium 238	3.0×10^{-9}	—	—
Plutonium 239	3.1×10^{-8}	—	—
Plutonium 240	7.0×10^{-9}	—	—
Plutonium 241	1.8×10^{-7}	—	—
Plutonium 242	6.4×10^{-13}	—	—
Americium 241	3.2×10^{-10}	—	—
Filter/Dry Sludges (All IDC's except 89, 99, 332)			
Plutonium 238	2.6×10^{-9}	—	—
Plutonium 239	3.0×10^{-8}	—	—

Process Radionuclides	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Plutonium 240	6.6×10^{-9}	—	—
Plutonium 241	1.7×10^{-7}	—	—
Plutonium 242	6.1×10^{-13}	—	—
Americium 241	3.1×10^{-10}	—	—
Immobilization (Vitrification) of Sludges			
Plutonium 238	3.0×10^{-9}	—	—
Plutonium 239	3.5×10^{-8}	—	—
Plutonium 240	8.0×10^{-9}	—	—
Plutonium 241	2.0×10^{-7}	—	—
Plutonium 242	7.2×10^{-13}	—	—
Americium 241	3.6×10^{-10}	—	—
Blend Down of Sludges			
Plutonium 238	2.7×10^{-9}	—	—
Plutonium 239	3.1×10^{-8}	—	—
Plutonium 240	7.1×10^{-9}	—	—
Plutonium 241	1.8×10^{-7}	—	—
Plutonium 242	6.4×10^{-13}	—	—
Americium 241	3.2×10^{-10}	—	—
Blend Down of Sludges (IDC's 89, 99, 332)			
Plutonium 238	9.0×10^{-11}	—	—
Plutonium 239	1.0×10^{-9}	—	—
Plutonium 240	2.3×10^{-10}	—	—
Plutonium 241	6.1×10^{-9}	—	—
Plutonium 242	2.2×10^{-14}	—	—
Americium 241	1.1×10^{-11}	—	—
Dissolution (Nitric Acid) of Sludges			
Plutonium 238	6.1×10^{-9}	—	—
Plutonium 239	7.1×10^{-8}	—	—
Plutonium 240	1.6×10^{-8}	—	—
Plutonium 241	4.1×10^{-7}	—	—
Plutonium 242	1.5×10^{-12}	—	—
Americium 241	7.6×10^{-10}	—	—
Repackage of Sludges (IDC's 089, 099, and 332)			
Plutonium 238	9.5×10^{-11}	—	—
Plutonium 239	1.1×10^{-9}	—	—
Plutonium 240	2.5×10^{-10}	—	—
Plutonium 241	6.4×10^{-9}	—	—
Plutonium 242	2.3×10^{-14}	—	—
Americium 241	1.1×10^{-11}	—	—
Neutralize/Dry Raschig (Glass) Rings			
Plutonium 238	N/E	—	—
Plutonium 239	N/E	—	—
Plutonium 240	N/E	—	—
Plutonium 241	N/E	—	—
Plutonium 242	N/E	—	—
Americium 241	N/E	—	—
Immobilization (Vitrification) of Raschig (Glass) Rings			
Plutonium 238	5.0×10^{-10}	—	—
Plutonium 239	5.8×10^{-9}	—	—
Plutonium 240	2.2×10^{-10}	—	—
Plutonium 241	3.3×10^{-8}	—	—
Plutonium 242	1.2×10^{-13}	—	—

Process Radionuclides	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Americium 241	6.0×10^{-11}	—	—
Blend Down of Raschig (Glass) Rings			
Plutonium 238	5.0×10^{-10}	—	—
Plutonium 239	5.8×10^{-9}	—	—
Plutonium 240	2.2×10^{-10}	—	—
Plutonium 241	3.3×10^{-8}	—	—
Plutonium 242	1.2×10^{-13}	—	—
Americium 241	6.0×10^{-11}	—	—
Sonic Wash of Raschig (Glass) Rings			
Plutonium 238	N/E	—	—
Plutonium 239	N/E	—	—
Plutonium 240	N/E	—	—
Plutonium 241	N/E	—	—
Plutonium 242	N/E	—	—
Americium 241	N/E	—	—
Mediated Electrochemical Oxidation for Raschig (Glass) Rings			
Plutonium 238	1.3×10^{-9}	—	—
Plutonium 239	1.5×10^{-8}	—	—
Plutonium 240	3.3×10^{-9}	—	—
Plutonium 241	8.5×10^{-8}	—	—
Plutonium 242	3.0×10^{-13}	—	—
Americium 241	1.5×10^{-10}	—	—
Direct Repackaging of Graphite			
Plutonium 238	N/E	—	—
Plutonium 239	N/E	—	—
Plutonium 240	N/E	—	—
Plutonium 241	N/E	—	—
Plutonium 242	N/E	—	—
Americium 241	N/E	—	—
Preprocess Graphite at Rocky Flats for Transport to the Savannah River Site			
Plutonium 238	4.9×10^{-9}	—	—
Plutonium 239	5.6×10^{-8}	—	—
Plutonium 240	1.3×10^{-8}	—	—
Plutonium 241	3.3×10^{-7}	—	—
Plutonium 242	1.2×10^{-12}	—	—
Americium 241	5.8×10^{-10}	—	—
Immobilization (Cementation) of Graphite			
Plutonium 238	2.0×10^{-8}	—	—
Plutonium 239	2.3×10^{-7}	—	—
Plutonium 240	5.2×10^{-8}	—	—
Plutonium 241	1.3×10^{-6}	—	—
Plutonium 242	4.8×10^{-12}	—	—
Americium 241	2.4×10^{-9}	—	—
Immobilization (Vitrification) of Graphite			
Plutonium 238	9.5×10^{-9}	—	—
Plutonium 239	1.1×10^{-7}	—	—
Plutonium 240	2.5×10^{-8}	—	—
Plutonium 241	6.4×10^{-7}	—	—
Plutonium 242	2.3×10^{-12}	—	—
Americium 241	1.1×10^{-9}	—	—
Blend Down of Graphite			
Plutonium 238	9.5×10^{-9}	—	—

Process Radionuclides	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Plutonium 239	1.1×10^{-7}	—	—
Plutonium 240	2.5×10^{-8}	—	—
Plutonium 241	6.4×10^{-7}	—	—
Plutonium 242	2.3×10^{-12}	—	—
Americium 241	1.1×10^{-9}	—	—
Mediated Electrochemical Oxidation for Graphite			
Plutonium 238	2.4×10^{-8}	0.000024	—
Plutonium 239	2.8×10^{-7}	0.000026	—
Plutonium 240	6.2×10^{-8}	—	—
Plutonium 241	1.6×10^{-6}	—	—
Plutonium 242	5.8×10^{-12}	—	—
Americium 241/243	2.9×10^{-9}	0.000017	—
Direct Repackage of Inorganic Residue			
Plutonium 238	N/E	—	—
Plutonium 239	N/E	—	—
Plutonium 240	N/E	—	—
Plutonium 241	N/E	—	—
Plutonium 242	N/E	—	—
Americium 241	N/E	—	—
Preprocess Inorganics at Rocky Flats for Transport to the Savannah River Site			
Plutonium 238	9.0×10^{-10}	—	—
Plutonium 239	1.1×10^{-8}	—	—
Plutonium 240	2.3×10^{-9}	—	—
Plutonium 241	6.1×10^{-8}	—	—
Plutonium 242	2.1×10^{-13}	—	—
Americium 241	1.1×10^{-10}	—	—
Immobilization (Vitrification) of Inorganics			
Plutonium 238	2.0×10^{-9}	—	—
Plutonium 239	2.3×10^{-8}	—	—
Plutonium 240	5.2×10^{-9}	—	—
Plutonium 241	1.3×10^{-7}	—	—
Plutonium 242	4.8×10^{-13}	—	—
Americium 241	2.4×10^{-10}	—	—
Blend Down of Inorganics			
Plutonium 238	1.8×10^{-9}	—	—
Plutonium 239	2.0×10^{-8}	—	—
Plutonium 240	4.6×10^{-9}	—	—
Plutonium 241	1.1×10^{-7}	—	—
Plutonium 242	4.2×10^{-13}	—	—
Americium 241	2.1×10^{-10}	—	—
Mediated Electrochemical Oxidation for Inorganics			
Plutonium 238	4.4×10^{-9}	0.000004	—
Plutonium 239	5.2×10^{-8}	0.000004	—
Plutonium 240	1.2×10^{-8}	—	—
Plutonium 241	3.0×10^{-7}	—	—
Plutonium 242	1.1×10^{-12}	—	—
Americium 241/243	5.3×10^{-10}	2.9×10^{-6}	—
Direct Repackage of Scrub Alloy Residue			
Plutonium 238	2.0×10^{-8}	—	—
Plutonium 239	2.3×10^{-7}	—	—
Plutonium 240	5.2×10^{-8}	—	—
Plutonium 241	1.4×10^{-6}	—	—

Process Radionuclides	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Plutonium 242	4.8×10^{-12}	—	—
Americium 241	1.3×10^{-6}	—	—
Repackaging of Scrub Alloy at Rocky Flats for Shipment to the Savannah River Site			
Plutonium 238	6.5×10^{-9}	—	—
Plutonium 239	7.5×10^{-8}	—	—
Plutonium 240	1.7×10^{-8}	—	—
Plutonium 241	4.4×10^{-7}	—	—
Plutonium 242	1.6×10^{-12}	—	—
Americium 241	6.5×10^{-7}	—	—
Immobilization (Calcination/Vitrification) of Scrub Alloy Buttons			
Plutonium 238	3.0×10^{-8}	—	—
Plutonium 239	3.5×10^{-7}	—	—
Plutonium 240	7.7×10^{-8}	—	—
Plutonium 241	2.0×10^{-6}	—	—
Plutonium 242	7.2×10^{-12}	—	—
Americium 241	1.9×10^{-6}	—	—
Existing Scrub Alloy Purex System			
Plutonium 238	—	0.000045	—
Plutonium 239	—	0.000048	—
Americium 241/243	—	0.000032	—
Pyrochemical Salts Scrub Alloy Purex System			
Plutonium 238	—	0.00022	—
Plutonium 239	—	0.00023	—
Americium 241/243	—	0.00015	—

N/E = no emissions

[a] All releases were to the atmosphere.

Note: Ash includes the general categories of incinerator ash/firebrick fines (78%), graphite fines (6%), sand, slag, crucible (11%), and inorganic (5%).

Salt includes the categories of sodium chloride/potassium chloride (88%) and calcium chloride (12%).

Combustibles includes the categories of aqueous (44%), organic (30%), and dry (26%).

Filter media includes the categories of high-efficiency particulate air (83%) and Ful Flo (17%).

Source: SAIC 1998a.

Table D–23 Releases [a] per 1 gram-mix of Weapons-Grade Plutonium (Ci) for Processing Alternatives (Normal Operations) at Rocky Flats

Process Radionuclides	*Releases (per 1 gram-mix)*
Plutonium 238	0.005
Plutonium 239	0.058
Plutonium 240	0.013
Plutonium 241	0.34
Plutonium 242	1.2×10^{-6}
Americium 241 [b]	0.0006

[a] All releases were to the atmosphere.

[b] For all salt and scrub alloy processes, there was an extra independent quantity (not within the weapons-grade mix) of Americium-241 released from operational procedures. One gram of Americium-241 contains 3.4 curies.

Source: SAIC 1996.

Table D–24 Radiological Impacts Due to Incident-Free Management of Plutonium Residues and Scrub Alloy—Rocky Flats Maximum Impacts

Material	*Offsite Population*		*Offsite Maximally Exposed Individual*		*Worker Population*	
	Collective Dose (person-rem)	*Latent Cancer Fatalities (number of cancers)*	*Annual Dose (mrem)*	*Cancer Probability*	*Collective Dose (person-rem)*	*Latent Cancer Fatalities (number of cancers)*
Incinerator Ash	0.0051	2.55×10^{-6}	0.00024	1.20×10^{-10}	376	0.150
Sand, Slag, and Crucible	0.00077	3.85×10^{-7}	0.000036	1.80×10^{-11}	57	0.0228
Inorganic Ash	0.00029	1.45×10^{-7}	0.000013	6.50×10^{-12}	26	0.0104
Graphite Fines	0.00042	2.10×10^{-7}	0.000020	1.00×10^{-11}	30	0.012
Molten Salt Extraction/ Electrorefining Salts	0.0091	4.55×10^{-6}	0.00039	1.95×10^{-10}	664	0.266
Direct Oxide Reduction Salts	0.0031	1.55×10^{-6}	0.00015	7.50×10^{-11}	155	0.062
Combustibles	0.00016	8.00×10^{-8}	7.40×10^{-6}	3.70×10^{-12}	42	0.0168
Plutonium Fluorides	0.00098	4.90×10^{-7}	0.000043	2.15×10^{-11}	356	0.142
High-Efficiency Particulate Air Filter Media	0.00057	2.85×10^{-7}	0.000027	1.35×10^{-11}	84	0.034
Ful Flo Filter Media	0.00012	6.00×10^{-8}	5.70×10^{-6}	2.85×10^{-12}	28	0.011
Sludge Residues	0.00016	8.00×10^{-8}	7.40×10^{-6}	3.70×10^{-12}	39	0.016
Glass Residues	0.000038	1.90×10^{-8}	1.80×10^{-6}	9.00×10^{-13}	1.90	0.00076
Graphite Residues	0.00072	3.60×10^{-7}	0.000034	1.70×10^{-11}	36	0.0144
Inorganic Residues	0.00013	6.50×10^{-8}	6.30×10^{-6}	3.15×10^{-12}	7.4	0.0030
Scrub Alloy	0.0025	1.25×10^{-6}	0.000066	3.30×10^{-11}	142	0.0568
Totals	0.0242	0.0000121	0.00105	5.25×10^{-10}	2,044	0.818

Table D–25 Radiological Impacts Due to Incident-Free Management of Plutonium Residues and Scrub Alloy—Savannah River Site Maximum Impacts

Material	*Offsite Population*		*Offsite Maximally Exposed Individual*		*Worker Population*	
	Collective Dose (person-rem)	*Latent Cancer Fatalities (number of cancers)*	*Annual Dose (mrem)*	*Cancer Probability*	*Collective Dose (person-rem)*	*Latent Cancer Fatalities (number of cancers)*
Incinerator Ash	0.17	0.000085	0.0015	7.50×10^{-10}	231	0.0924
Sand, Slag, and Crucible	0.014	7.00×10^{-6}	0.00013	6.50×10^{-11}	17	0.0068
Inorganic Ash	N/A	N/A	N/A	N/A	N/A	N/A
Graphite Fines	0.0071	3.55×10^{-6}	0.000064	3.20×10^{-11}	12	0.0048
Salts	0.12	0.000062	0.0012	6.00×10^{-10}	120	0.048
Combustibles	N/A	N/A	N/A	N/A	N/A	N/A
Plutonium Fluorides	0.022	0.000011	0.00020	1.00×10^{-10}	34	0.0136
High-Efficiency Particulate Air Filter Media	N/A	N/A	N/A	N/A	N/A	N/A

Material	*Offsite Population*		*Offsite Maximally Exposed Individual*		*Worker Population*	
	Collective Dose (person-rem)	*Latent Cancer Fatalities (number of cancers)*	*Annual Dose (mrem)*	*Cancer Probability*	*Collective Dose (person-rem)*	*Latent Cancer Fatalities (number of cancers)*
Ful Flo Filter Media	N/A	N/A	N/A	N/A	N/A	N/A
Sludge Residues	N/A	N/A	N/A	N/A	N/A	N/A
Glass Residues	N/A	N/A	N/A	N/A	N/A	N/A
Graphite Residues	0.014	7.00×10^{-6}	0.00012	6.00×10^{-11}	25	0.010
Inorganic Residues	0.0023	1.15×10^{-6}	0.000021	1.05×10^{-11}	4.50	0.0018
Scrub Alloy	0.0255	0.0000128	0.00024	1.20×10^{-10}	25	0.010
Totals	0.375	0.000187	0.00348	1.74×10^{-9}	469	0.187

N/A = not applicable (these materials are not processed at the Savannah River Site)

Table D–26 Radiological Impacts Due to Incident-Free Management of Plutonium Residues—Los Alamos Maximum Impacts

Material	*Offsite Population*		*Offsite Maximally Exposed Individual*		*Worker Population*	
	Collective Dose (person-rem)	*Latent Cancer Fatality (number of cancers)*	*Annual Dose (mrem)*	*Cancer Probability*	*Collective Dose (person-rem)*	*Latent Cancer Fatality (number of cancers)*
Incinerator Ash	N/A	N/A	N/A	N/A	N/A	N/A
Sand, Slag, and Crucible	N/A	N/A	N/A	N/A	N/A	N/A
Inorganic Ash	N/A	N/A	N/A	N/A	N/A	N/A
Graphite Fines	N/A	N/A	N/A	N/A	N/A	N/A
Salts	0.00235	1.18×10^{-6}	0.000799	4.00×10^{-10}	160	0.064
Combustibles	N/A	N/A	N/A	N/A	N/A	N/A
Plutonium Fluorides	N/A	N/A	N/A	N/A	N/A	N/A
High-Efficiency Particulate Air Filter Media	N/A	N/A	N/A	N/A	N/A	N/A
Ful Flo Filter Media	N/A	N/A	N/A	N/A	N/A	N/A
Sludge Residues	N/A	N/A	N/A	N/A	N/A	N/A
Glass Residues	N/A	N/A	N/A	N/A	N/A	N/A
Graphite Residues	N/A	N/A	N/A	N/A	N/A	N/A
Inorganic Residues	N/A	N/A	N/A	N/A	N/A	N/A
Scrub Alloy	N/A	N/A	N/A	N/A	N/A	N/A
Totals	0.00235	1.18×10^{-6}	0.000799	4.00×10^{-10}	160	0.064

N/A = not applicable (these materials are not processed at Los Alamos National Laboratory)

Tables D-24 through D-26 present the largest possible incident-free impacts associated with each residue type, that could exist at each site for all possible alternatives examined in this EIS. They should be viewed as a set of bounding values which cannot be exceeded for any of the processes under any feasible combination. The preferred and strategic alternatives also fall under the realm of being bounded by the impact quantities

presented in the tables. It should be noted that not all residue processes are applicable to each site; in these situations, N/A ("not applicable") is denoted in the appropriate locations.

D.3 ACCIDENT AND RISK ANALYSIS METHODOLOGY, ASSUMPTIONS, AND RESULTS

Section D.3 describes the methodology and assumptions used for estimating radiation exposure (dose) and the risk to individuals and the general public from releases of radioactivity resulting from potential accident scenarios during processing and stabilization of certain Rocky Flats plutonium residues.

D.3.1 Exposure Impacts To Be Evaluated

The impact of radiation exposure on the following segments of the population is calculated for each accident scenario:

- **Worker—**An individual (a noninvolved worker) located 100 m (330 ft) from the radioactive material release point.[1] The dose to the worker is calculated for the 50th-percentile meteorology only, as specified in DOE-STD-1027-92 (DOE 1992). Workers are exposed unprotected to the plume for a limited time (a maximum of 5 minutes). Workers are exposed to radioactivity via inhalation, air immersion, and ground surface pathways only.

- **Maximally Exposed Individual—**A hypothetical individual living at the management site boundary and receiving the maximum exposure. The hypothetical member of the public is located directly downwind of the accident and is exposed to radioactivity via inhalation, ingestion, air immersion, and ground surface pathways. The individual would be exposed to the plume for the entire release duration.

- **Population—**The general public living within an 80-km (50-mi) radius of the facility, residing directly downwind of the accident, and receiving the maximum exposure via inhalation, ingestion, air immersion, and ground surface pathways.

The doses to the maximally exposed individual and the general public are calculated for the 50th- and 95th-percentile meteorological conditions. The details of exposure times for maximally exposed individuals, workers, and the general public are given in Section D.1.2.2.

The radiation dose to individuals and the public resulting from exposure to radioactive contamination was calculated using the following potential pathways:

- *Air Immersion*—External direct exposure from immersion in the airborne radioactive material
- *Ground Surface*—External direct exposure from radioactive material deposited on the ground
- *Inhalation*—Internal exposure from inhalation of radioactive aerosols and suspended particles
- *Ingestion*—Internal exposure from ingestion of contaminated terrestrial food and animal products.

The radiation dose is estimated by the GENII computer program in a manner recommended by the International Commission on Radiological Protection in Publications 26 and 30 (ICRP 1977, ICRP 1982). Committed dose

[1] *For elevated release, the worker dose was calculated at a point of maximum dose. The distance at which the maximum dose occurs is frequently greater than 100 m (330 ft) for an elevated release.*

equivalents[2] are calculated individually for organs such as the gonads, breast, red bone marrow, lungs, thyroid, and bone surface; calculations are combined for the liver, upper large intestine, lower large intestine, small intestine, and stomach. Weighting factors are used for various body organs to calculate weighted or committed effective dose equivalent from radiation inside the body due to inhalation or ingestion. The committed effective dose equivalent value is the summation of the committed dose equivalent to a specific organ weighted by the relative risk to that organ compared to an equivalent whole-body exposure. Deep-dose equivalent for the external exposure pathways (immersion in the radioactive material and exposure to the ground contamination) and 50-year committed effective dose equivalent for the internal exposure pathways are calculated. The sum of the deep-dose equivalent for external pathways and committed effective dose equivalent for internal pathways is called the total dose in this EIS.

The exposure from ingestion of contaminated terrestrial food and animal products is calculated on a yearly basis. It is expected, however, that continued consumption of contaminated food products by the public would be suspended if the projected dose should exceed that of the protective action guidelines in a radiological accident event (EPA 1991). No reduction of exposure because of protective actions or evacuation of the public was accounted for in this analysis, however. This conservative approach may result in overestimating health effects within an exposed population but allows for consistent comparisons between alternatives.

D.3.2 Selection of Facility Accidents for Detailed Evaluations

The large number of material categories and the processing technologies under consideration in this EIS produce more than 50 different process/material combinations that need to be evaluated (see Figure 2–2 of this EIS). The selected technologies are either (1) well established with active facilities currently in operation or (2) considered to be feasible (existing laboratory scale) and becoming operational in the near future. For the well-established processing technologies with active facilities, the selection of accident scenarios is based on those evaluated in the facility safety analysis reports. For those processing technologies that have not been in full production, a set of similar process-independent accidents are postulated.

Postulated facility accident scenarios were developed based on the review of the analyzed accidents in previous safety analysis, risk assessment, and environmental assessment documents at Rocky Flats, Savannah River Site, and Los Alamos National Laboratory facilities where plutonium is handled or processed.

After reviewing a wide range of documents, postulated accident scenarios were developed based on information contained in the following:

- *Safety Analysis-200 Area, Savannah River Site F-Canyon Operation, F-Canyon SAR Addendum* (WSRC 1994)
- *Basis for Interim Operation, Savannah River Site H-Canyon and Outside Facilities, H-Canyon Basis for Interim Operation* (WSRC 1996)
- *Safety Analysis, H-Canyon Basis for Interim Operation Addendum, Addendum 1, Revision 0* (WSRC 1997)
- *Nuclear Safety Technical Report, Safety Analysis in Support of the Environmental Assessment for Consolidation and Interim Storage of Special Nuclear Material in Building 371* (EG&G 1995)

[2]*The definitions of committed dose equivalents, committed effective dose equivalents, and total effective dose equivalents are consistent with those given in 10 Code of Federal Regulations (CFR) Part 835, "Occupational Radiation Protection; Final Rule" (DOE 1993a).*

- *Environmental Assessment, Finding of No Significant Impact, and Response to Comments, Solid Residue Treatment, Repackaging, and Storage* (DOE 1996d)

- *Basis for Interim Operation Building 371/374 Complex, Rocky Flats Environmental Technology Site* (KHC 1997a)

- *TA-55 Final Safety Analysis Report* (LANL 1996).

Based on this review of analyzed accident scenarios at Rocky Flats, Savannah River Site, and Los Alamos National Laboratory facilities that deal with plutonium, a spectrum of potential accidents was identified. This process started with systematically identifying initiating events, subsequent accident progressions, and onsite or offsite releases. Then, based on accident initiators, selected accidents were grouped into the following three categories:

- Natural phenomena (e.g., earthquake, tornado),
- External events (e.g., aircraft crash), and
- Process-related events (e.g., explosion, nuclear criticality, fire, spills).

The potential process-related events include high-, medium-, and low-energetic events, which are defined as follows:

- *High-Energetic*—A high-energetic event is defined as one that releases sufficient energy to destroy the first confinement barrier and breach the secondary confinement barrier, allowing radioactive materials to directly reach rooms occupied by personnel or directly reach the environment outside the facility. An example of such event would be an explosion of a magnitude that potentially could produce severe damage to the glovebox and cause damage to the filtration system or the building confinements (walls), creating a direct path to the environment. If an explosion could not create a direct path to the environment, it is covered as a medium-energetic impact event.

- *Medium-Energetic*—A medium-energetic event is defined as one that would cause penetration of the primary confinement barrier and potentially cause materials to bypass the second confinement barrier for a short period of time. Events which could lead to medium-energetic events are nuclear criticality, uncontrolled chemical reaction (including a sudden eruption or belching of a content of vessel, foaming, boil over, gassing, or simply an undesirable high temperature resulting in material degradation or toxic vapor evolution), fire (spontaneous combustion involving plutonium, cellulose, and other strong oxidizing agents such as nitric acid), and impacts (a projectile or a dropped object impacting process equipment).

- *Low-Energetic*—A low-energetic event is defined as one that would not destroy the primary confinement barrier, but activity may penetrate it. These events usually occur due to human errors such as transfer errors, overflows, chemical addition errors, spills, over pressurization, and equipment failures such as leaks.

The energy categorization is one of the indices that affects the outcome of all components of the building source term except the material at risk (see Section D.3.3.2). Under some circumstances, therefore, the health effects of a medium-energetic event could exceed those of a high-energetic event. A careful review of the accidents will lead to the amount of materials at risk as being the major contributing factor to the results that appear to be counterintuitive at first glance.

A review of the accident scenarios indicated that only severe accident conditions could result in a significant release of radioactive material to the environment or an increase in radiation levels. Some types of accidents, such as procedure violations, spills of small materials containing radioactive particles, and most other types of common human error occur more frequently than the more severe accidents analyzed. However, these accidents do not involve enough radioactive material or radiation to result in significant release to the environment. Natural phenomena (e.g., earthquake) and fire accidents creating a direct path for releases to the environment represented the situation with the most consequences to the public. The process-related accidents occurred inside the building, and, therefore, represented the situation with the most significant consequences to the operational personnel. The airborne particles from a process-related accident would normally pass through at least one bank and possibly two to four banks of high-efficiency particulate air filters before entering the environment. Plutonium handling and operations are performed inside such confinement barriers as gloveboxes or canyon walls. The gloveboxes are equipped with safety significant features, such as inert gas atmosphere, pressure control, and heat detection. These features are credited when their operabilities can be ensured.

Based on these reviews and on guidance provided by DOE in Section 6.9 of *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993d), the following types of accidents were selected for each processing technology:

- Explosions
- Nuclear criticality
- Fire
- Earthquake
- Aircraft crash
- Spills.

Finally, no specific analyses of the results of terrorist or sabotage acts were considered. This is because the existing security measures in effect at the management sites would essentially preclude any sabotage or terrorist activity. In addition, any acts of terrorism are expected to result in consequences that are bounded by the results of the accident scenarios selected for detailed evaluation.

Table D–27 summarizes the selected accident scenarios and the associated frequency ranges. Details of the actual frequency, given in the following sections, are site specific.

Table D–27 Selected Accident Scenarios

Accident Type	*Scenario*	*Frequency Range (per year)*
High-Energy Impact	Explosion	$10^{-3} > \text{Frequency} > 10^{-6}$
Medium-Energy Impact	Nuclear Criticality [a] Fire: a. Room b. Dock	$10^{-2} > \text{Frequency} > 10^{-5}$ $10^{-2} > \text{Frequency} > 10^{-4}$
Low-Energy Impact	Spills: a. Outside Glovebox b. Inside Glovebox c. Loading Dock	$\text{Frequency} > 10^{-3}$
Natural Phenomena	Earthquake (DBE)	$10^{-2} > \text{Frequency} \geq 10^{-4}$
External Event	Aircraft Crash	$10^{-5} > \text{Frequency}$
Severe Accident	Earthquake (BDBE) Earthquake with Fire	$10^{-4} > \text{Frequency} \geq 10^{-7}$

DBE = design (evaluation) basis earthquake BDBE = beyond design basis earthquake.

[a] Only plutonium criticalities are evaluated. The potential for an americium criticality was considered but dismissed because of the limited americium mass and purity. Americium is only present in plutonium residues in small quantities.

Note: Event frequencies are site dependent.
For the beyond design basis events (severe accidents) only events with frequencies above 10^{-7} per year are considered. Events with lower frequencies are considered to be not reasonably foreseeable.

D.3.3 Accident Evaluation

D.3.3.1 Basic Assumptions

Unless otherwise stated, the following conditions were used in the calculations:

❒ Meteorological Data

- Site-specific joint frequency distribution weather data are used to define 50- and 95-percentile meteorological conditions for each processing technology at management sites.
- The release is assumed to occur at an elevated level, unless otherwise stated, consistent with the site's effluent emission stack height. No credit is taken for jet plume rise through the stack.
- Mixing layer height is 1,000 m (3,280 ft). Airborne materials freely diffuse in the atmosphere near the ground level in what is known as the mixing depth. A stable layer exists above the mixing depth and restricts vertical diffusion above 1,000 m.
- Wet deposition is zero (it is assumed that no rains occur to accelerate deposition and reduce the size of area affected by the release).
- Dry deposition of the cloud is modeled. During movement of the radioactive plume, a fraction of the radioactive material in the plume is deposited on the ground due to gravitational forces. The quantity of deposited radioactive material is proportional to the particle size and deposition velocities (in meters per second). For the plutonium isotopes, the deposition velocity is 0.001 m/sec. The deposited material contributes to the exposure from ground surface radiation and ingestion.

❒ Inhalation Data

- Breathing rate is 330 cubic centimeters (cm^3)/sec (0.7 cubic feet per minute [ft^3/min]) for the worker and the general public at the site boundary and beyond (maximally exposed individual and population) during the passage of the plume; it is 270 cm^3/sec (0.57 ft^3/min) for the general public during the other times.
- Particle size is 1.0 microns (0.04 mils).
- Solubility (or lung clearance) class[3] (for dose effect when inhaled) in this analysis will use class "Y" for plutonium oxides and class "W" for other plutonium compounds such as fluorides and metals.
- The internal exposure period is 50 years for the individual organs and tissues evaluated.

D.3.3.2 Source Term

[3] *A classification of inhaled material based on its clearance half-time, in order of days "D," weeks "W," or years "Y," from the pulmonary region of the lung to the blood and gastrointestinal tract.*

The source term (or building source term) is the amount of respirable radioactive material that is released to the air, in terms of Curies or grams. The airborne source term is typically estimated by the following five-component linear equation:

Source term = MAR × DR × ARF × RF × LPF

where:

MAR	=	Material-at-Risk (grams or curies)
DR	=	Damage Ratio
ARF	=	Airborne Release Fraction (or Airborne Release Rate for continuous release)
RF	=	Respirable Fraction
LPF	=	Leak Path Factor.

- **Material at Risk—**The material at risk is the amount of the radionuclides (in Curies or gram of activity for each radionuclide) available to be acted upon by a given physical stress (i.e., an accident). The material at risk is specific to a given process in the facility of interest. It is not necessarily the total quantity of material present but is that amount of material in the scenario of interest postulated to be available for release.

- **Damage Ratio—**This is the fraction of material exposed to the effects of the energy/force/stress generated by the postulated event. For the accident scenarios discussed in this document, the value of the damage ratio is assumed to be one, unless otherwise specified.

- **Airborne Release Fraction—**This is the fraction of the material that becomes airborne due to the accident. In this analysis, airborne release fraction values from the DOE Handbook on airborne release fraction are used (DOE 1994a).

- **Respirable Fraction—**This is the fraction of the material, with particle size of 10-micrometers (microns) aerodynamic equivalent diameter or less, that could be retained in the respiratory system following inhalation. The respirable fraction values are also taken from the DOE Handbook on airborne release fractions (DOE 1994a).

- **Leak Path Factor—**The leak path factor accounts for the action of removal mechanisms (e.g., containment systems, filtration, deposition) to reduce the amount of airborne radioactivity that is ultimately released to occupied spaces of the facility or the environment. A leak path factor of one (i.e., no reduction) is assigned in accident scenarios involving a major failure of confinement barriers.

D.3.3.3 Process Accident Scenario Description and Source Terms

This section describes the accident scenarios and corresponding source terms developed for Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory. The spectrum of accidents described below were used to determine the incremental consequences (public and worker doses) and risks associated with the processing of certain Rocky Flats' residues at each site. These accident scenarios are consistent with those evaluated in either the facility safety analysis report, facility/site environmental reports, or various related DOE safety documents. Secondary accidents were considered when identified in the safety documents. The selected documents were identified and referenced in each of the accident scenarios described. When information was required to further clarify the accident condition, update some of the parameters, and facilitate the evaluation process, additional assumptions were made. Sometimes it was necessary to have different assumptions than

those that were used in the referenced report. These are also identified. For example, the material at risk during an earthquake is different for the residue processing in this EIS than those considered in the facility safety analysis report. This change in assumption is necessary because the evaluations in this EIS focus only on the incremental risk resulting from the implementation of alternatives. Cumulative risks can be determined by adding the incremental risks to the existing risks.

D.3.3.3.1 Accident Scenarios Description and Source Terms at Rocky Flats

❒ **Description of Accident Scenarios—**The following accident scenarios are evaluated for each processing technology and material category considered in this EIS. Each accident scenario description sets the condition of the accident and provides a summary of material involved. As stated earlier, these accident scenarios are generic, but their applications are consistent with those evaluated in various Rocky Flats environmental and safety analyses documents (EG&G 1995, KHC 1997a, DOE 1996d). It is important to note that even though these accident scenarios are based on the existing production technologies, they will also be applicable to the new technologies because the new technologies are similar to the production technologies at operational levels. Additionally, these accidents are generic and process-independent.

- *Explosion*—Two explosion scenarios were postulated: acetylene and ion exchange explosions. The acetylene explosion was postulated to occur in both Building 707 and Building 371, whereas the ion exchange explosion was postulated to occur in Building 371 only. The acetylene explosion scenario was considered credible and analyzed for Buildings 371 and 707 (EG&G 1995). The scenario assumed for the analysis in this EIS is consistent with that analyzed earlier. The scenario assumes the development of a flammable cloud of acetylene in the vicinity of a glovebox. The source of the acetylene gas is the failure of an oxy-acetylene welding rig. The subsequent deflagration can result in damage to equipment and containers within the immediate vicinity of the explosion. The ensuing pressure wave from deflagration could breach the module wall and blow open a set of egress doors in Building 707, creating a path to the environment (EG&G 1995). The explosion force from an acetylene accident in Building 371 would be insufficient to damage the 40-cm (16-in) thick reinforced concrete outer building walls (EG&G 1995). Therefore, the release path would be through at least two banks of high-efficiency particulate air filters. The frequency of this accident was estimated at 5×10^{-5} per year (EG&G 1995). The material at risk for this EIS was considered to be the equivalent content of two drums.

  Ion exchange purification of plutonium is a secondary process for the plutonium separation processing alternative that uses the mediated electrochemical oxidation process. There are two alternative protocols possible—the purification of each batch using lab-scale columns or the accumulation of sufficient batches to make up an appropriate quantity of plutonium for use of a process-size column. Because the accumulation of plutonium results in a larger source term (a conservative assumption), this option is selected for evaluation. The accident was assumed to result from a strong exothermic reaction between nitric acid and the base resin during the elution phase of the plutonium purification process. The material at risk was assumed to be 1.6 kilograms (kg) (3.53 lb) of plutonium based on the processing schedule and throughput estimates of batch sizes. The accident scenario assumptions and evolutions are similar to those of the FB-Line ion-exchange explosion described in Section D.3.3.2 with the exception that no release is postulated for the feed tank. This is because the event is postulated to occur after the feed tank is emptied into the column and additional material has not had a chance to accumulate. The Rocky Flats ion exchange columns are made up of 15-cm (6-in) borosilicate glass pipe wrapped in heavy mesh screen and are not assumed to generate fragments with an adequate force to defeat the carbonate plastic windows. Airborne release from the formation of a "flashing spray" from the eluate with boiling of the remaining solution due to the burning of the released resin on the

floor of the glovebox are evaluated. The released materials would pass through at least two banks of high-efficiency particulate air filters, giving a leak path factor of 2×10^{-6}. The release from the building stack is estimated to be 0.245 mg (5.4×10^{-7} lb) of plutonium. The frequency of such an event was estimated to be 1×10^{-4} per year, consistent with that used for the same event at the Savannah River Site.

- *Room Fire*—A fire originating in the room could involve multiple gloveboxes. The fire could be initiated by welding, an electrical short, or other causes. The frequency of a room fire involving two gloveboxes was estimated to be 5×10^{-4} per year (EG&G 1995). This fire frequency was used in this EIS to represent a fire involving the entire room. Workers would evacuate the fire zone in about 20 seconds, and it is assumed that only one glovebox would be involved in the fire during this period. The amount of the combustibles in the room is insufficient to plug the filters, and the sprinklers would cool the fire plume sufficiently; therefore, no buoyancy effect is considered. The sprinkler effect would limit the amount of material that could be involved in the fire. The material at risk was assumed to be a 5-day supply for operation. The types of materials considered are high americium residues for the salts and aged weapon-grade plutonium for other residues. It was assumed that at least two banks of filters would be available. A fraction of the released material could bypass the ventilation system by escaping the room through cracks in egress doors. Because the ventilation system was assumed to be operating, approximately 10 percent of the material (due to temperature and air volume increase before the sprinkler started) was assumed to escape through the cracks.

- *Dock Fire*—A dock fire resulting in a direct release to the atmosphere is estimated to have a likelihood of 2×10^{-6} per year, based on the consideration that historically there were no dock fires, and the dock doors are open only one percent of the time (EG&G 1995). For the worker handling the materials inside the dock, the likelihood of the fire would be 2×10^{-4} per year. Various ranges of dock fires have been postulated at Rocky Flats (KHC 1997a, EG&G 1995). The scenario that was evaluated here assumes a large dock fire similar to the scenario evaluated in the Building 371 Basis for Interim Operation report (KHC 1997a). In this scenario, the material at risk was considered to be the contents of four plutonium residue drums. A conservative bounding mass, assuming that the content is in powder form, was used to estimate the mass (plutonium content) of a drum. Because the ventilation system would be in operation, it was assumed that approximately 50 percent of the released material would enter the atmosphere directly. The remaining airborne releases would pass through at least two banks of high-efficiency particulate air filters before entering the atmosphere.

- *Dock Spill*—A dock spill could occur if a package is dropped on the dock while loading and unloading a truck, resulting in breach of the drum and inner container and release of plutonium. This assumption is very conservative, because all containers used at Rocky Flats are required to withstand a 120-cm (4-ft) drop without loss of contents. The spill could result if the container is damaged or improperly sealed. The likelihood of occurrence of such an event was estimated to be 10^{-3} per year (EG&G 1995). The material at risk was assumed to be the content of one drum at its maximum limit. The event at worst would impact approximately 25 percent of the content. Upon a spill, the workers, both those involved with the operation and those not directly involved (e.g., security and drivers), would evacuate the area within 20 seconds. The workers handling the packages are required to wear respirators that would reduce their intake of contaminants by 99 percent. Because the ventilation system would be in operation, it was assumed that about 10 percent of the released material would directly enter the atmosphere. The remaining airborne releases would pass through at least two banks of high-efficiency particulate air filters before entering the atmosphere.

- *Room Spill*—A room spill could be caused by human error or deteriorated packaging materials during a transfer process. The material could be dry (metal/powder) or liquid. The workers handling the

packaging materials are required to wear respirators. The frequency of occurrence of a dry spill was estimated to be 8×10^{-3} per year, based on a human error probability of 1×10^{-3} of dropping a container, a probability of 1×10^{-2} that the container fails and releases its contents as a result of drop, and an assumption that a bag-in occurs once per shift (3 shifts/day × 5 days/week × 50 weeks/year). The material at risk is assumed to be the content of one container at its limit. Liquid spill is a potential for activities in Building 371. In the Building 371 Basis for Interim Operation report (KHC 1997a), several scenarios for liquid spills (small to large) have been analyzed. In this EIS, the analysis considers a spill equivalent to a batch size solution volume. The spilled solution is assumed to flow by gravity into the criticality drain system. For the environmental assessment purposes, this analysis assumes that the likelihood of such an event in Building 371 is 8×10^{-3} per year.

- *Glovebox Spill*—A spill inside a glovebox could occur due to human error. This spill would be confined inside the glovebox. The probability of occurrence of such an event is estimated to be 0.8 per year, based on similar assumptions of human reliability and operational activities as stated for the room spill scenario. The immediate workers would be exposed to the spilled materials if a tear occurred in the gloves simultaneously with the spill and some of the materials escaped from the glovebox. For the purposes of this EIS, it was assumed that, at most, 1 percent of the materials released to the glovebox could escape through the tear and enter the room. The probability of such an event was estimated to be 8×10^{-2} per year, based on the probability of a glove tear of 0.10 per year (EG&G 1995). The material at risk is assumed to be the content of one feed preparation container (the size of one batch).

- *Earthquake*—An evaluation (design) basis earthquake would cause different consequences to Buildings 707 and 371 at Rocky Flats. Building 707 is expected to collapse from an earthquake having a peak ground acceleration of 0.106 g with a return period of about 385 years (frequency of 2.6×10^{-3} per year) (CAI 1997). The collapse of Building 707 would cause the collapse of the eastern portion of Building 707A which houses Modules J through K (CAI 1997). Building 371 is not expected to collapse from earthquakes with a return period of less than 10,700 years (frequency of 9.4×10^{-5} per year) (CAI 1995). For Building 707, a 0.106 peak ground acceleration (design basis earthquake) earthquake was assumed. Such an earthquake would cause widespread damage throughout Building 707, which houses Modules A through H, and Building 707A, which houses Modules J through K. The consequences of such an accident involving various plutonium and transuranic waste materials have already been analyzed in the building safety analysis report. For this EIS, the material at risk was assumed to be that of a 5-day supply in different packages and gloveboxes within the operational area. The released materials were assumed to enter the environment through a leak path factor of 0.10.

  The assumption of a leak path factor of 0.1 in an earthquake is based on the following combination of factors considered: (1) after an earthquake, the building fails before the materials are released (due to impact); (2) the released materials are buried, or confined, under the rubble; (3) minimal air flow is available to force the material out; and (4) structural debris acts as a filter, absorbing the particulates as they pass through before entering the environment. In addition, DOE-HDBK-3010 (DOE 1994a) recommends an order of magnitude reduction of the airborne release fraction for powders buried under debris. The values given for the airborne release fraction did not consider such a reduction, and this reduction was assigned to the leak path factor.

  The consequences of several levels of earthquakes have also been evaluated in the Building 371 Basis for Interim Operation report (KHC 1997a). The minimum peak ground acceleration that could cause equipment damage resulting in material release was estimated to be 0.15 g with a 900-year return period (frequency of 1.1×10^{-3} per year). At this peak ground acceleration level (design basis earthquake), the following accidents could occur: spills, fire, and explosion. A criticality event was not considered as

likely, because no damage to the equipment containing liquids was expected at this earthquake level. Spills were assumed to occur in the laboratories, downdraft tables, and gloveboxes. Fire was postulated to occur anywhere within Building 371. It was assumed that a large fire could occur and could pressurize the facility resulting in a high ambient leak path factor of 0.1. The fire was considered to eventually burn itself out, or be extinguished by the fire department. Explosion was postulated to occur in the analytical laboratory involving propane gas. The propane explosion was assumed to topple a glovebox, causing its contents to spread in the room. The explosion was assumed to cause a high leak path factor of 0.10.

With a 2,000-year return period (frequency of 5×10^{-4} per year) earthquake, 0.25 peak ground acceleration, it was postulated that in addition to events identified above, a criticality event could also occur from a mixture of materials in the collapsed gloveboxes and water from failed fire suppression systems (moderated and fully reflected metal criticality). A nuclear criticality may be characterized by a flash of fissions that produce a pulse of penetrating radiation, followed by a period of much lower radiation lasting from a few minutes to several hours depending on the self limiting properties of critical mass. A criticality event is very different from a nuclear detonation, which is almost instantaneous fissions of all materials. There is no potential for a nuclear detonation at the site. Due to the uncertainties in the ways that a criticality accident could occur, for the purposes of analysis in this EIS, a criticality event with a 10^{18} fission yield was assumed, that is, a single burst or pulse of fissions (DOE 1994a). The fission gas release source term for this criticality event was assumed to be 1/10 of the values provided in the Nuclear Regulatory Commission's Regulatory Guide 3.35 (NRC 1979); the source term in this regulatory guide is for a plutonium solution criticality event with 10^{19} fissions.

- *Criticality*—Various criticality events were postulated to occur during plutonium processing and handling activities. These are bare plutonium metal criticality, water moderated and reflected plutonium criticality, and plutonium solution criticality. Among these accidental events, criticality in plutonium solutions is expected to yield the highest amount of fissions. DOE-HDBK-3010-94 (DOE 1994a) identifies the following fission yields for each of the above criticality events:

  - Bare metal 10^{17} fissions
  - Fully moderated and reflected solid metal 10^{18} fissions
  - Solution 10^{19} fissions

  The amount of fission gas and halogen nuclide source terms from a criticality event is proportional to the number of fissions per event. A solution criticality will have 100 times more of these nuclides than will a bare metal criticality and also will release aerosols (particulate plutonium), which a bare metal criticality will not. A fully moderated and reflected solid metal criticality will produce 10 percent of the amount of fission gas and halogen source terms that is released in a solution criticality, and it will release no plutonium particulates. The solution criticality will dominate any other criticality event. The 10^{-4} per year frequency for a criticality event already considers violation of two administrative controls. The frequency of a solid criticality event will not be higher than 10^{-4} per year. Therefore, for analysis purposes, only solution criticality is modeled and evaluated. The frequency of a plutonium solution criticality is estimated at 1×10^{-4} per year (EG&G 1995). The source term for the solution criticality is given in **Table D–28**.

Table D–28 Criticality Source Term for 10^{19} Fissions in Plutonium Solution

Isotope	*Radioactivity (Ci)* [a]			*ARF* [b]	*LPF* [c]	*Source Term (Ci)*
	0-30 minutes	*30 min-8 hours*	*Total*			
Kr-83m	15	95	110	1	1	110
Kr-85m	9.9	61	70.9	1	1	70.9
Kr -85	0.00012	0.00072	0.00084	1	1	0.00084
Kr-87	60	370	430	1	1	430
Kr-88	32	200	232	1	1	232
Kr-89	1,800	11,000	12,800	1	1	12,800
Xe-131m	0.014	0.086	0.1	1	1	0.1
Xe-133m	0.31	1.9	2.21	1	1	2.21
Xe-133	3.8	23	26.8	1	1	26.8
Xe-135m	460	2,800	3,260	1	1	3,260
Xe-135	57	350	407	1	1	407
Xe-137	6,900	42,000	48,900	1	1	48,900
Xe-138	1,500	9,500	11,000	1	1	11,000
I-131	1.5	9.5	11	0.25	1	2.75
I-132	170	1,000	1,170	0.25	1	293
I-133	22	140	162	0.25	1	40.5
I-134	600	3,700	4,300	0.25	1	1,080
I-135	63	390	453	0.25	1	113
Pu-238 [c, d]			3.6	0.0005	0.005	0
Pu-239 [c, d]			170	0.0005	0.005	0.00043
Pu-240 [c, d]			39	0.0005	0.005	0.0001
Pu-241 [c, d]			2,400	0.0005	0.005	0.006
Pu-242 [c, d]			0.003	0.0005	0.005	7.50×10^{-9}

Ci = curie ARF = airborne release fraction LPF = leak path factor

[a] Regulatory Guide 3.35 (NRC 1979).

[b] Airborne release fractions are equal to 1.0 for noble gases, 0.25 for iodine, and 0.0005 for plutonium; all particles are assumed to be in the respirable range (i.e., Respirable Fraction = 1.0).

[c] Plutonium in 100 liters of solution.

[d] This plutonium is assumed to be released to the atmosphere through a high-efficiency particulate air filter (e.g., the Savannah River Site's sand filter) with a 0.995 efficiency. For Rocky Flats, the plutonium source terms are smaller by a factor of 0.0004 due to a higher number of filter banks. The plutonium values are the maximum solution concentration in the FB-Line (DOE 1993b).

- *Aircraft Crash*—Rocky Flats is located between 6.4 to 8 km (4 to 5 mi) from Jeffco airport and approximately 32 km (20 mi) from Denver International Airport. A hypothetical aircraft crash accident scenario into Buildings 707, 707A, and/or 371 was postulated. The frequency of such an event was estimated using the DOE Standard on *Accident Analysis for Aircraft Crash into Hazardous Facilities*, DOE-STD-3014-96 (DOE 1996b). This standard identifies that the aircraft (general aviation aircraft) crashes occurring during in-flight and takeoff and landing operations at Jeffco airport along with the potential crashes during in-flight operation of other aircrafts (e. g., air carriers, military aircraft) would

need to be considered as potential hazards to Rocky Flats facilities. Using the facility dimensions of Building 707, it was determined that the frequency with which a large commercial (air taxi and larger sizes) and/or a high-powered military aircraft could crash into this building would be less than 10^{-7} per year. For the general aviation aircraft, an upper bound frequency of a crash into Buildings 707, 707A, or 371 was estimated to be 3×10^{-5}, 1×10^{-5} and 4×10^{-5} per year, respectively. The likelihood that a general aviation aircraft would hit the dock areas of Building 707 is approximately two orders of magnitude less (i.e., 2.2×10^{-7} per year). The crash of a general aviation aircraft into the building would not be as severe (both in magnitude and frequency) as that of an earthquake. Therefore, the consequences/risks of an earthquake would bound that of an aircraft crash. For analysis purposes, the material at risk for this scenario was assumed to be equal to that used in a 0.13 peak ground acceleration design basis earthquake.

❒ **Assumptions of Airborne Release Fraction and Respirable Fraction Values for Rocky Flats' Accident Scenarios—Table D–29** summarizes the airborne release fraction and respirable fraction values for each of the accidents and the types of materials involved. To differentiate the risks between various residue-processing combinations, an attempt is made to highlight the responses of the residue forms to different stresses. Airborne release fraction and respirable fraction factors are selected based on the best information available that would provide this separation between material forms. These values may be different from those used in the safety analysis documentation where the objectives are to "bound" potential releases. The technical bases for selection of these values are given in the next paragraph.

Assignment of the appropriate airborne release fractions and respirable fractions for residue materials was based on the categorization of the residue materials by pertinent physical characteristics that affect airborne suspension and assumption of the most suspendible form of the material. For the purposes of these analyses, the residue forms were categorized as follows:

- *Powders*—Ash residues; sand, slag, and crucible residues; fluoride residues; pyrochemical salt residues; and graphite residues
- *Surface Contamination on Solid Surfaces*—Combustible residues, including Ful Flo filter residues; glass residues; high-efficiency particulate air filter medium residues; inorganic residues
- *Metal*—Scrub alloy residues.

The accidents and the assumptions used to estimate the airborne release fraction and respirable fraction values are summarized in the following paragraphs.

Acetylene Explosion—This is an event that releases energy external to the residue material containers and generates a pressure impulse that impacts sealed 208-liter (L) (55-gallon [gal]) metal drums and gloveboxes nearby. It may displace or topple drums and gloveboxes and could potentially damage them. The displacement/toppling of the drums subjects both the surface contamination on the plastic wrap/ container holding the residue materials and the residue materials themselves. The contamination displaced from the plastic wrap and the container can be vented by failure of the plastic wrap and can be released to the ambient atmosphere. The residue materials suspended inside the container have an additional barrier, the container seal, nonetheless, a conservative assumption is made that any materials airborne within the container also are vented.

- *Powder*—The values for suspension of a powder due to the impact of falling debris (DOE 1994a), an airborne release fraction of 1×10^{-3} with a respirable fraction of 0.1, are applied for residue materials categorized as powders. Two exceptions are noted for the respirable fraction of residue materials in this category:

- Unpublished test data for the respirable fraction for the finer fraction of pyrochemical salt residues, developed at Rocky Flats, indicate the respirable fraction for the residue does not exceed 0.001. This respirable fraction value is applied here, because the effects of explosions are not expected to further reduce the size of the material (i.e., make it more respirable).
- The size distribution of the initial fluoride residue are coarse and do not generate high respirable fractions under the accident stresses tested (e.g., thermal stress of fluoride powder generated overall respirable fractions ranging from 1×10^{-5} to 1×10^{-7}); therefore, a respirable fraction of 0.01 is applied here.

- *Surface Contamination on Solid Surfaces*—For residue materials categorized as surface contamination of solid surfaces, the airborne release fraction and respirable fraction values cited previously are also applied, except for the respirable fraction value for the high-efficiency particulate air filter medium residue. The high-efficiency particulate air filter medium is a very fine (4-micrometer diameter) glass fiber matrix. Larger airborne particles are collected on the surface on the mat and smaller particles are collected in the matrix. The collected particles tend to be agglomerated (stuck together). The finer fraction that would be part of the respirable fraction is surrounded and attached to the internal surfaces of the glass fiber and is difficult to suspend. Therefore, a respirable fraction value of 0.01 is applied for this material.

Table D–29 Airborne Release Fraction and Respirable Fraction Values for the Accident Scenarios at Rocky Flats

	Ash Residue [a]		*Pyro-Salts*		*Combustibles*		*Fluorides*		*Filter-Media*		*Glass Residue*		*Inorganic*		*Scrub Alloy* [b]	
Accident	***ARF***	***RF***	***ARF***	***RF***	***ARF***	***RF***	***ARF***	***RF***	***ARF***	***RF***	***ARF***	***RF***	***ARF***	***RF***	***ARF***	***RF***
Explosion	0.001	0.1	0.001	0.001	0.001	0.1	0.001	0.01	0.001	0.01	0.001	0.1	0.001	0.10	0.001	0.01
Dock Fire [c]	0.006	0.01	0.006	0.01	0.0005	1.00	0.001	0.001	0.006	0.01	0.006	0.01	0.006	0.01	0.006	0.01
Room Fire [d]	0.006	0.01	0.006	0.01	0.0005	1.00	0.001	0.001	0.006	0.01	0.006	0.01	0.006	0.01	0.006	0.01
Dock Spill	0.00008	0.5	0.00008	0.001	1.00×10^{-6}		0.00008	0.5	1.00×10^{-6}		1.00×10^{-6}		1.00×10^{-6}		1.00×10^{-6}	
Room Spill	0.00002	0.5	0.00002	0.001	See filter media		0.00002	0.01	Materials opened in the glovebox. No spill is considered						1.00×10^{-6}	
Glovebox Spill	0.00002	0.5	0.00002	0.001	1.00×10^{-6}		0.00002	0.01	1.00×10^{-6}		1.00×10^{-6}		1.00×10^{-6}		1.00×10^{-6}	
Earthquake Powder Spill [e]	0.002	0.3	0.002	0.3	0.001	0.1	0.002	0.3	0.002	0.3	0.001	0.1	0.001	0.1	0.001	0.1
Earthquake Liquid Spill	0.00005	0.7	0.00005	0.7	0.00005	0.7	0.00005	0.7	0.00005	0.7	0.00005	0.7	0.00005	0.7	0.00005	0.7

ARF = airborne release fraction RF = respirable fraction

[a] The airborne release fraction and respirable fraction values given for ash residues apply to graphites; sand, slag, and crucible; dried sludge residues; and other ash residues.

[b] A damage ratio of 0.01 is applied to scrub alloy. This is based on the assumption that less than 1 percent of the alloy undergoes corrosion on the surface of the metal. The values given below are for the surface corrosion/contamination products.

[c] Damage ratio of 1.0 for combustible and 0.01 for all others

[d] For graphites ARF=0.01, and RF=0.001, for Ful Flo filters ARF=0.0005 and RF=1.0. Damage ratio of 0.01 for the scrub alloy.

[e] For scrub alloy, the airborne release fraction value is applied to the surface corrosion; assume 1 percent of the mass is corroded, or a damage ratio of 0.01. The airborne release fraction and respirable fraction values do not include the potential for resuspension of particulates after the earthquake. A resuspension value of 1.92×10^{-4} needs to be added to all ARF×RF values.

- *Metal*—Only one residue material, scrub alloy, has the physical characteristics corresponding to the elastic-plastic deformation properties of metals. The shock-vibration stress induced by this event would not result in fragmentation of a metal and only corrosion products in particulate form on the outer surface of a metal would be affected. The respirable fraction has been diminished to reflect the assumption that less than 1 percent of the surface is corroded.

Dock Fire—The event postulated is an external fire that ignites the combustible materials in four sealed 208-L (55-gal) metal drums containing packaged residue materials. In most cases, the materials ignited are the combustible packaging materials. One category, combustibles, can ignite and burn and these materials are not always packaged inside the drums but are often a mixture of small plastic wrapped bundles of contaminated combustibles and loose potentially contaminated combustibles.

- *Powder*—Residue forms categorized as powder are predominantly plutonium oxide, a chemically unreactive material. The airborne release fraction and respirable fraction for this category of particles under thermal stress are 6×10^{-3} and 0.01, respectively (DOE 1994a). The airborne suspension for fluorides was experimentally measured, and the values—an airborne release fraction of 1×10^{-3} with a respirable fraction of 0.001—are applied here.

- *Surface Contamination on Solid Surface*—One material form in this category, combustibles, can be ignited, and the airborne release has been experimentally measured (DOE 1994a). An airborne release fraction of 5×10^{-4} with a conservative assumption of 1.0 for the respirable fraction are applied. The remaining materials are considered chemically unreactive particles under thermal stress, and the airborne release fraction and respirable fraction applied for powder is used.

- *Metal*—Although the aluminum alloy may melt at higher temperatures, the airborne release from the residue form is considered the suspension of a chemically inert particle resulting from corrosion (conservatively assumed to be 1 percent of the total mass of the material) of the alloy under thermal stress and the airborne release fraction and respirable fraction applied for powder is used.

Room Fire—The event postulated is the ignition of the combustible contents of sealed 208-L (55-gal) metal drums by an external heat source and the same airborne release fraction and respirable fraction values applied for the dock fire are used.

Dock Spill—Two events could result in the spill of the contents of the sealed 208-L (55-gal) metal drums during unloading. One or more drums could fall from the pallet during movement by a forklift and unseal by the force of the impact with the floor. The contents could spill from their containers due to the loss of the container seal and fall out of the containers due to the impact. The distance the material would spill is very small, less than 30 cm (1 ft).

The contents could be released by the inadvertent puncture of the drum and package by the forks of the vehicle during an attempt to off load the pallet. The forks are normally inserted at the bottom of the pallet and punctures near the base of the drum would be necessary for released material to fall from the drum after withdrawal of the forks. Since the level of the vehicle and dock are nearly at the same elevation, the fall distance for the material is less than 1 meter (3.3 ft).

- *Powder*—The maximum experimentally measured airborne release for a dry, cohesionless powder, with a density approximately that of plutonium oxide, for a fall distance of 1 m (3.3 ft) is an airborne release fraction of 8×10^{-5} with a respirable fraction of 0.5. These values are used for this category of residue material.

- *Surface Contamination on Solid Surfaces*—Under the conditions postulated (the puncture of the sealed 208-L [55-gal] metal drums and packaging by the forks of a forklift and the release of materials by withdrawal of the forks), the solid materials are not expected to fall from the drums except for incidental pieces that may be near the holes and are of the size to pass through the holes. Any suspension of the surface contamination would result from the shock-vibration due to the impact of the small piece with the floor. Some materials, such as combustibles, are not dense and their impact would not generate substantial forces. Therefore, the [airborne release fraction][respirable fraction] values of this material are assumed to be $\leq 1\times10^{-6}$. The combined airborne release fraction and respirable fraction values for surface-contaminated materials (filter media, glass residue, inorganic residues) are assumed to be less than those for the free-fall spill of a powder because the release from these material results from dislodgement by shock-vibration and suspension by turbulence generated by the falling object. Because the postulated scenario assumes that the drums are toppled during transport, even if these residue forms are released from the drums (which in reality have to pass through an inner container, two layers of plastic wrap, and the sealed metal drum), the material falls a short distance (inches) and rolls rather than impacting the hard, unyielding surface assumed for shock-vibration effects. Furthermore, the powder associated with high-efficiency particulate air filter media are attached to the surface of the medium in the filter frame, and the physical form of the filters discourages rolling.

  The combined value for the scrub alloy is based on the assumption that (1) the material is a metal that would not be deformed significantly by such a short fall and (2) the airborne release would only affect any surface corrosion products. Scrub alloy may be stored for appreciable periods of time before processing; some surface corrosion is inevitable and the [airborne release fraction] [respirable fraction] for shock vibration for surface contamination is 10^{-4}. If the corrosion is assumed to affect 1 percent of the total mass of scrub alloy, then the [airborne release fraction][respirable fraction] value of 10^{-6} is reasonably bounding for this phenomenon.

Room Spill—For powder-like residues in containers, a spill may occur inside the gloveboxes due to handling and pouring of the materials during the residue processing. The floors of the gloveboxes are elevated approximately 0.90 m (3 ft) in most cases to allow handling at the normal height for personnel. The potential fall distances are very small, ranging from a few centimeters (a few inches) during some pouring operations to 30 cm (1ft) if the container topples off a stand.

- *Powder*—The airborne release fraction and respirable fraction have been experimentally measured for the free-fall spill of dry, cohesionless powders of materials with high (uranium dioxide) and low (titanium dioxide) density with very fine size distributions of particles (the mass median diameters of both powders were approximately 1 to 2 micrometers geometric diameter). The minimum fall distance of 1 m (3.3 ft) was used. The airborne release fraction values ranged from 2×10^{-5} to 5×10^{-4} with respirable fraction values from 0.40 to 0.93 (DOE 1994a). Given that the maximum fall distance postulated for the event is approximately one-third the fall distance used in the experiments, the smallest measured value for the airborne release fraction of 2×10^{-5} and an average respirable fraction value for the data set of 0.5 are applied here. One exception is noted for fluoride residues; because of their demonstrated behavior, a respirable fraction of 0.01 is applied.

- *Surface Contamination on Solid Surfaces*—This category of materials is not bagged into the gloveboxes; the drum opening is inserted into the glovebox and the materials removed or poured onto the glovebox floor. Thus, spills are a normal activity during processing and are not considered an inadvertent event.

- *Metal*—Spills involving metal that exhibit elastic-plastic deformation falling short distances do not normally result in fragmentation of the metal. The impact with an unyielding surface could generate adequate shock-vibration forces to dislodge some particulate surface contamination. Because very little corrosion products on the outer surfaces of the scrub alloys are expected, an [airborne release fraction][respirable fraction] value of $\leq 1\times10^{-6}$ is applied.

Earthquake-Initiated Spill, Building 707—The event postulated is the complete failure of the structure and the spill of the glovebox contents due to toppling of the gloveboxes. It is assumed that materials are stored in sealed 208-L (55-gal) drums and that the metal drums fail. Crushing of the inner packages holding the residue materials is not anticipated due to the protection of the drums' contents by physical barriers.

- *Powders in the Glovebox*—It is assumed that residues in powder form may be in open containers and could be violently spilled during the toppling of the glovebox. The maximum measured values for the free-fall spill of dry, cohesionless particles for a distance of 3 m (10 ft) are an airborne release fraction of 2×10^{-3} with a respirable fraction of 0.3 (DOE 1994a) and are applied to this category of residues.

- *Surface Contamination on Solid Surfaces*—The suspension stress for this category of residue is the shock-vibration due to seismic acceleration, the impact of the glovebox with the floor due to toppling, and the impact of debris from the structure failure on the toppled glovebox structure. The maximum measured values for the impact of debris on powders are an airborne release fraction of 1×10^{-3} with a respirable fraction of 0.1 (DOE 1994a). For filter media, the powder values cited above were applied, due to a potential for the presence of fine, loose powder shaken from the media during handling and transport.

- *Metals in Glovebox*—The assumption is made that the shock-vibration forces described above suspend the surface corrosion products on the outer surface of the scrub alloy. It is conservatively assumed that 1 percent of the scrub alloy has corroded. Thus, the damage ratio is 0.01.

Earthquake-Initiated Free-Fall Spill, Building 371—For the operations in Building 371, all residue forms would be in liquid form due to the activities performed during processing (e.g., neutralization and shredding, sonic washing) and all materials are assigned the airborne release fraction and respirable fraction values for the release resulting from the free-fall spill of aqueous solutions, because the liquids are too dilute to act as slurries and are not viscous. Although the liquid is not a concentrated aqueous solution of heavy metal, it is assumed that the liquid would behave as such due to the presence of the heavy metal oxide particles. The maximum measured value for the free-fall spill of concentrated heavy metal solution from a 3-m (10-ft) or less height is 2×10^{-5} with a respirable fraction of 0.26 and 0.3 (DOE 1994a). Larger respirable fractions are found with other airborne release fraction values. For a respirable fraction value of 0.7, the maximum measured value, an airborne release fraction of 5×10^{-5} is applied here.

Earthquake-Initiated Fire, Building 371—At the acceleration level postulated for the design basis earthquake, analyses show that Building 371 would not fail. An airborne release would be due to the behavior and interaction of equipment and materials within the facility. The most severe consequences would result from the effect of fire initiated by the seismic event. Thus, the values cited for room fires are applicable to this situation.

Earthquake-Initiated Explosion, Building 371—As stated above, failure of the structure is not postulated for the design basis earthquake level of ground acceleration and the most severe consequences result from an explosion initiated by the seismic event.

D.3.3.3.2 Accident Scenarios Description and Source Terms at the Savannah River Site

❒ **Description of Accident Scenarios at the Savannah River Site—**The following facilities would be used to store or process Rocky Flats' plutonium residues at the Savannah River Site—F-Canyon (or H-Canyon), FB-Line (or HB-Line), plutonium storage facility, new special recovery facility, and Building 235 storage vault. The F-Canyon, FB-Line, new special recovery facility, and plutonium storage facility are part of the Building 221-F (or F-Canyon) structure. The H-Canyon and HB-Line are part of Building 221-H. Two processes will be used to separate the plutonium from the residues at the Savannah River Site: the mediated electrochemical oxidation process and the Purex process. In the mediated electrochemical oxidation process, the Rocky Flats plutonium residues are processed by dissolving ashes, graphite, and inorganics at the new special recovery facility; transferring the solution to the F-Canyon for separating and concentrating the plutonium solution; then pumping the solution to FB-Line for purification and solidification of plutonium metal (see the processing descriptions in Appendix C of this EIS). In the Purex process, the residues will be dissolved in the F-Canyon dissolvers and the process follows similar to the one stated earlier. The flow process at H-Canyon, in the mediated electrochemical oxidation process, starts with the dissolution of ashes, graphites, and inorganics in two new (to be installed later) silver dissolvers; thus is followed by the separation and concentration of plutonium; then the solution is pumped to the HB-Line facility for purification and oxidation, filtration, and separation of the plutonium oxide. The Purex process at H-Canyon can use the existing dissolvers, and the process will be similar to that of the mediated electrochemical oxidation process after the dissolution of residues. There are two main differences between the operations at F-Canyon and at H-Canyon. First, the final product from the H-Canyon processes is plutonium oxide powder, and that from F-Canyon is plutonium metal button. Second, when the Rocky Flats residues are processed at H-Canyon, the whole facility, including the HB-Line, will be dedicated to this operation; at F-Canyon, however, processing may be dedicated to the Rocky Flats residues or may include site-specific materials along with the Rocky Flats residues. Therefore, when the process becomes dissolver limited, the HB-Line operation will become intermittent.

Because processing operations at the Savannah River Site differ from those at Rocky Flats, process-dependent accident scenarios were postulated. These accident scenarios, defined in the following paragraphs, are applicable to the processing facilities as a whole (i.e., F-Canyon, H-Canyon, FB-Line, HB-Line, and new special recovery facilities). The mix of principal radionuclide releases from new special recovery, F-Canyon (H-Canyon), and FB-Line (HB-Line) was assumed to be similar to that of the Rocky Flats residues processed.

The consequences of potential accident scenarios for the vault and storage facilities are subsumed by the consequences of the hypothesized process accidents. This is because the repackaged residue materials received at the Savannah River Site would remain in their shipping containers while they are in storage vaults. The materials will be taken from the shipping containers outside of the storage vaults at the new special recovery, H-Canyon, or F-Canyon facility before being dissolved. Therefore, no accident scenarios that could result in releases comparable to those postulated for the processing were identified.

- *Explosion*—Two major explosions are postulated: hydrogen and ion exchanger explosions. In defining these explosion scenarios, the facility safety analysis reports as well as the DOE safety survey reports were reviewed to identify the bounding accident in one of the three facilities. Hydrogen explosion is bounded by the accident in the F-Canyon or the H-Canyon dissolver. The analysis of maximum hydrogen generation and explosion in the safety survey concluded the accident would not cause any building damage (DOE 1993c). The released materials would pass through the sand filter before entering the atmosphere. The probability of such an explosion was estimated to be 1.5×10^{-5}

per year (DOE 1993c). The combined [airborne release fraction][respirable fraction] for this accident was estimated to be 1×10^{-3} and would be independent of the type of materials dissolved. It was assumed that the dissolver content would be spread to the canyon floor.

An explosion in an ion exchange column in the FB-Line or HB-Line is postulated to result from a strong exothermic reaction between nitric acid and the base resin in the cation (or anion) exchange column during plutonium solution exchange. This would result in a thermally induced pressure failure of the ion exchange vessel and the resulting shrapnel would damage the product run tank and the product hold tank for this ion exchange pair. The explosion would breach the glovebox confinement. The plutonium in nitrite solution in the run and hold tanks would spill onto the cabinet floor and boil due to a subsequent resin fire. Based on the assumptions that the column was at its maximum load before the explosion and the maximum quantity of liquid at the maximum allowable concentration was present, the estimated release of plutonium through the sand filter and the stack was calculated to be 0.241 g of plutonium (DOE 1993b). The frequency of such an event is estimated to be 1×10^{-4} per year (DOE 1993b).

- *Fire*—In the F-Canyon safety analysis report (WSRC 1994) and the H-Canyon Basis for Interim Operation report (WSRC 1997), a fire was postulated to occur in the second plutonium cycle solvent extraction. The frequency of such a fire was estimated at 6.1×10^{-4} per year (WSRC 1994, WSRC 1997). The accident was assumed to burn the content of one tank. The material at risk, depending on the type of residue processed, would range from 1,000 to 12,000 g of plutonium. See **Table D–30** and **Table D–31** for details. The combined [airborne release fraction][respirable fraction] was estimated to be 1×10^{-2} (DOE 1994a). The airborne materials would pass through sand filter, with a leak path factor of 0.005, before entering the atmosphere.

Table D–30 Material at Risk, Airborne Release Fraction, Respirable Fraction, and Leak Path Factor Values for Savannah River Site F-Canyon Accident Scenarios

	Material at Risk [a]										
Accident	*Ash MEO*	*Ash Purex*	*SSC*	*Graphite*	*Salt-Scrub*	*Fluoride*	*Inorganic*	*Scrub Alloy*	*ARF×RF*	*LPF*	*Source Term (mg Pu)*
Explosion (hydrogen)	3	2	1	2	4	2	2	4	10^{-3}	0.005	Varies
Explosion (ion) [b]	180.75	120.5	60.25	120.5	241	120.5	120.5	241	N/A	N/A	Varies
Fire [c]	3	2	1	2	4	2	2	4	10^{-2}	0.005	Varies
Earthquake (F-Canyon)	9	6	3	6	12	6	6	12	0.000028 0.000019 [d]	0.10	Varies
Earthquake (FB-Line)	3	2	1	2	4	2	2	4	0.002 (p) [e] 0.0022 (m) 0.000047(l) 0(s)	0.10	Varies
Spill [f]	178	–	–	103	–	–	79	–	10^{-5}	0.005	Varies

MEO = mediated electrochemical oxidation SSC = sand, slag, and crucible ARF= airborne release fraction RF = respirable fraction LPF = leak path factor Pu = plutonium N/A = not applicable

[a] The material-at-risk values are in terms of number of buttons produced. Each button is 2,000 g of plutonium.

[b] The values provided here are source term values in milligrams of plutonium released to the atmosphere through the stack. This value is arrived at by considering all combinations of accidents that follow an ion exchange explosion.

[c] Fire in the FB-Line would result in consequences that are a factor of 40 smaller than those presented here.

[d] This value corresponds to resuspended airborne respirable fraction. This number is added to 2.8×10^{-5} to get a combined value of 4.7×10^{-5} for the ARF×RF.

[e] These values include both the initial and resuspended ARF×RF values and p = powder, m = molten metal, l = liquid., and s = solid. (New buttons have no oxidation on the surface; thus, there is no release because of an earthquake.)

[f] The material-at-risk values given for the spill are in grams of plutonium.

Note: The combined value of ARF×RF is presented as opposed to individual values for each item as presented for Rocky Flats. This is because the ARF and RF values in Rocky Flats accident scenarios are material type and form dependent, whereas, those in Savannah River Site are in liquid (plutonium nitrite) or powder (plutonium oxide) form. The Savannah River Site ARF×RF values are independent of material type.

Table D–31 Material at Risk, Airborne Release Fraction, Respirable Fraction, and Leak Path Factor Values for Savannah River Site H-Canyon Accident Scenarios

	Material at Risk [a]										
Accident	*Ash MEO*	*Ash Purex*	*SSC*	*Graphite*	*Salt-Scrub*	*Fluoride*	*Inorganic*	*Scrub Alloy*	*ARF×RF*	*LPF*	*Source Term (mg Pu)*
Explosion (hydrogen)	6	1	1	4	6	1	4	6	10^{-3}	0.005	Varies
Explosion (ion) [b, c]	241	241	241	241	241	241	241	241	N/A	N/A	241
Fire [d]	6	3	3	6	6	3	6	6	10^{-2}	0.005	Varies
Earthquake (H-Canyon)	18	54	54	27	18	54	27	18	0.000028 0.000019 [e]	0.10	Varies
Earthquake (HB-Line) [c]	8	8	8	8	8	8	8	8	0.002 (p) [f] 0.000047 (l)	0.10	Varies
Spill [g]	178	–	–	103	–	–	79	–	10^{-5}	0.005	Varies

MEO = mediated electrochemical oxidation SSC = sand, slag, and crucible ARF= airborne release fraction RF = respirable fraction
LPF = leak path factor Pu = plutonium N/A = not applicable

[a] The material-at-risk values are in terms of number of cans produced. Each can is approximately 1,000 g of plutonium.

[b] The values provided here are source term values in milligrams of plutonium released to the atmosphere through the stack. This value is arrived at by considering all combinations of accidents that follow an ion exchange explosion.

[c] These values are for full and dedicated operation of HB-Line. These values need to be multiplied by the HB-Line duty cycle for each process. The duty cycles are as follows: ash Purex, and fluoride processes = 12.5%; graphite and inorganic processes = 60%; and ash MEO, salt scrub, and scrub alloy processes = 100%.

[d] Fire in the HB-Line would result in consequences that are a factor of 40 smaller than those presented here.

[e] This value corresponds to resuspended airborne respirable fraction. This number is added to 2.8×10^{-5} to get a combined value of 4.7×10^{-5} for the ARF×RF.

[f] These values include both the initial and resuspended ARF×RF values and p = powder and l = liquid.

[g] The material-at-risk values given for the spill are in grams of plutonium.

Note: The combined value of ARF×RF is presented as opposed to individual values for each item as presented for Rocky Flats. This is because the ARF and RF values in Rocky Flats accident scenarios are material type and form dependent, whereas, those in Savannah River Site are in liquid (plutonium nitrite) or powder (plutonium oxide) form. The Savannah River Site ARF×RF values are independent of material type.

- *Criticality*—A plutonium solution criticality was postulated. The criticality was assumed to consist of an initial burst of 1×10^{18} fissions in 0.5 seconds, followed at 10-minute intervals for the next 8 hours by bursts of 2×10^{17} fissions, for a total of 1×10^{19} fissions as specified in the Nuclear Regulatory Commission's Regulatory Guide 3.35 (NRC 1979) and NUREG-1320 (NRC 1988) and in the DOE-HDBK-3010-94 (DOE 1994a) report. The 10^{19} fission yield was based on the assumptions that the solution criticality occurred in a tank with a minimum volume of 3,785 L (100 gal) and that approximately 100 L of this volume evaporated due to heat released during the fission process. Based on the data provided in the DOE safety survey report (DOE 1993c), a 10^{19} criticality event in the FB-Line process would result in the bounding source term (Table D–28 gives the source terms). The frequency of such an event was estimated to be 1×10^{-4} per year, consistent with that used in the Rocky Flats analysis.

- *Earthquake*—Recent analyses of earthquake hazards at F-Canyon and H-Canyon indicate that a 0.24-g peak ground acceleration level earthquake—with a return period of 8,000 years (or a frequency of 1.25×10^{-4} per year) for the F-Canyon facility and a return period of 5,500 years (or a frequency of 1.82×10^{-4} per year) for the H-Canyon facility—could damage the structure and cause localized interior failures as well as interior and exterior wall cracks (DOE 1996c, DOE 1996d). Previous analyses of earthquake hazards at F-Canyon and H-Canyon estimated the consequences of such a magnitude earthquake with a higher frequency of occurrences—2×10^{-4} per year (DOE 1995a, WSRC 1994, and WSRC 1997). Using the assumptions in the F-Canyon H-Canyon Facility Safety Analysis Reports (WSRC 1994, WSRC 1997), a new source term was developed for an earthquake accident involving Rocky Flats residues. Given an earthquake, it was assumed that the plutonium contents in all the processes (F-Canyon and FB-Line or H-Canyon and HB-Line) would be spilled on the canyon floor (the total material at risk for each residue category is shown in Tables D–30 and D-31). It was further assumed that the airborne material would enter the environment through the building cracks, which are formed by the loss of sealant between the sections because of differential motion of the section, with a penetration leak path factor of 0.10.

- *Aircraft Crash*—The location of the F-Canyon or H-Canyon facility is far away from any airport; therefore, no takeoff and landing crash accidents need to be considered. The crashes that could occur during in-flight would need to be considered. According to the DOE Standard on aircraft crash analysis, DOE-STD-3014-96 (DOE 1996b), the expected crash frequency for the site is approximately 2×10^{-4} per square-mile per year from general aviation, 6×10^{-7} and 2×10^{-6} per square-mile per year from air carrier and air taxies, respectively, and 1×10^{-7} and 6×10^{-7} per square-mile per year from large military and small military aircraft, respectively. Using the building dimensions and the data provided in the DOE Standard for aircraft crash analysis, an upper bound frequency for an aircraft crash into the canyon buildings was estimated to be 4.6×10^{-6} and 1.5×10^{-7} per year for general aviation and commuter (air taxi) aircraft, respectively. These values were calculated without considering any site-specific effects (e.g., the topography and building structures around the facility). Considering the available skid distance of 60 m (200 ft) that an aircraft could skid before hitting the building, the frequency of an air taxi crashing into the building would be less than 10^{-8} per year. When only crashes that directly hit the structure were considered, general aviation aircraft would have the only estimated crash frequency greater than 10^{-7} per year. The F-Canyon or H-Canyon building is a maximum resistant construction structure designed to withstand a pressure of 47.9 kilopascal (1,000 lb/ft^2). Therefore, crashes of small aircraft (helicopter or a small observation/security aircraft) into these buildings are not expected to damage the buildings. If a general aviation aircraft were to crash into the buildings, its consequences (both in magnitude and frequency) would be smaller than that hypothesized for a design basis evaluation earthquake.

- *Spill*—An accidental spill was postulated. The scenario assumed that the operator accidentally dropped a plutonium powder container while unloading the materials from the shipping containers. The spill was assumed to occur at the new special recovery (or H-Canyon) facility's dissolver area because only materials opened in the new special recovery (or H-Canyon) facility would be in powder form. The materials in the shipping containers opened at the F-Canyon (or existing H-Canyon) dissolver area would be in powder form or solid form but are sealed in dissolvable cans and placed in the dissolvers without being opened; therefore, the consequences of any accidental drop of one of these cans would be subsumed by that of the powder spill. The workers handling the shipping containers and unpacking of the materials are required to wear respirators. The airborne materials would pass through sand filter before entering the atmosphere. The frequency of occurrence of a spill was estimated to be 1×10^{-2} per year, based on the human error probability of 1×10^{-3} of dropping a container, a probability of 1×10^{-2} that the container was improperly bagged and packaged, and an

assumption that, on the average, a bag-in occurs once per shift (3 shifts/day × 5 days/week × 50 week/year). The material at risk was estimated to contain 206 g of powdered ash residues. The airborne release fraction and respirable fraction values for powder were estimated to be 2×10^{-5} and 0.5, respectively, consistent with those applied to the Rocky Flats event from materials and conditions.

❒ **Assessment of Material at Risk, Airborne Release Fraction, Respirable Fraction, and Leak Path Factor for Accidents at the Savannah River Site—**Tables D–30 and D–31 provide a summary of material at risk, airborne release fraction, respirable fraction, and leak path factor for accidents at the Savannah River Site. The material-at-risk values are representative of mass values for each material category that could be present at the time of an accident. These values are set based on the throughput of FB-Line (HB-Line) configuration to process the Rocky Flats residues. When a material at risk is less than the maximum value, it means that the Rocky Flats residues are being processed along with other Savannah River Site–specific materials. The values provided for the airborne release fraction and the respirable fraction are independent of the type of material processed. Therefore, for simplicity, a combined value is given for the airborne respirable fraction (i.e., [airborne release fraction]×[respirable fraction]).

As mentioned previously, the same airborne release fraction and respirable fraction values are applied to the events at the Savannah River Site for the same materials as were applied at Rocky Flats (see Section D.3.3.1). For the cases where more than one phenomenon resulted in airborne releases from a single event (e.g., an ion exchange explosion event), a composite value for [airborne release fraction]× [respirable fraction], weighted for the fraction of the material at risk involved with each phenomenon, is provided.

D.3.3.3.3 Accident Scenarios Description and Source Term at Los Alamos National Laboratory

❒ **Description of Accident Scenarios at Los Alamos National Laboratory—**Rocky Flats plutonium residues (pyrochemical oxides salts) will be received, processed, and stored in the Los Alamos National Laboratory plutonium facility, Building 4, at Technical Area 55. Two processing technologies will be used at Los Alamos National Laboratory (salt distillation of molten salt extraction and electrorefining residue salts and water leach of direct oxide reduction residue salts). The accident scenarios evaluated for these processing technologies follow. They are similar to those analyzed at Rocky Flats and the Savannah River Site and are consistent with those analyzed in the Technical Area 55 final safety analysis report (LANL 1996).

- *Explosions*—The Technical Area 55 safety analysis report considered two evaluation basis explosions: hydrogen explosions and ion exchange explosions (LANL 1996). Neither of these process-related explosions would breach the integrity of the gloveboxes proposed for the processing of the Rocky Flats residues because the proposed processing technologies do not use ion exchange and neither produce nor use hydrogen gas. The secondary impact from these explosions would have neither the energy nor the proximity to impact the proposed processing facilities.

- *Criticality*—The material and the proposed technology limit the potential criticality event to a fully moderated and reflected solid metal (solid particles) criticality event. DOE Handbook, DOE-HDBK-3010-94 (DOE 1994a), identifies the fission yields for such an event as on the order of 10^{18} fissions (i.e., a single pulse) with no plutonium particulate evaporation. The fission gas and iodine released from such a criticality event will be a factor of 10 less than those provided previously in Table D–28. The frequency of such an event was assumed to be 1×10^{-4} per year, consistent with that used for the same event at Rocky Flats and the Savannah River Site.

- *Fire*—The accident scenario assumes a room fire that breaches glovebox confinement coupled with the loss of room ventilation. This accident scenario is similar to the fire scenarios analyzed in the Technical Area 55 safety analysis report (LANL 1996). The likelihood of a room fire in this safety analysis report was estimated to be between 10^{-6} to 10^{-2} per year. For consistency with the room fire scenario analyzed for Rocky Flats, a room fire frequency of 5×10^{-4} was assumed. Analysis of the effect of a bounding evaluation basis fire in the Technical Area 55 safety analysis report concluded that the evaluation basis fire accident would not damage the glovebox exhaust high-efficiency particulate air filter plenums; based on the building airflow, it was estimated that only 1.1 percent of the airborne materials would enter the environment without passing through at least two banks of high-efficiency particulate air filters. The same assumption of leak path factor (i.e., 0.011) will be used in this EIS. The material at risk for this EIS was assumed to be the supply for 1 week (4 days per week) of operation. The material at risk for the salt distillation technology is a two-week supply because the nominal batch size for the calcination process exceeds one-week of product from the distillation process.

- *Spill*—A room spill scenario similar to that used for the Savannah River Site operation is assumed. The airborne materials would pass through three banks of high-efficiency particulate air filters before entering the environment. The material at risk is assumed to be the plutonium content in one of the containers of the shipping cask. The frequency of occurrence of a spill is assumed to be 3×10^{-3} per year, based on the human error probability of 1×10^{-3} of dropping a container, on a probability of 1×10^{-2} that the container was improperly bagged and packaged, and on the average likelihood that a bag-in occurs once per shift (1 shift/day × 4 days/week × 50 weeks/year).

- *Earthquake*—An evaluation basis earthquake with a mean peak ground acceleration of 0.3 g was assumed. The frequency of such a magnitude earthquake was estimated at be 5×10^{-4} per year (or having a 2,000-year return period). The building structure is designed to withstand an earthquake of this magnitude (LANL 1996). Such an earthquake, however, would result in the collapse of some process enclosures (e.g., glovebox, storage tanks, pipes) caused by anchorage failure, support stands, or interaction with other equipment. These failures are assumed to result in a free fall of material at risk within these enclosures. The Technical Area 55 safety analysis did not identify any other secondary event (i.e., criticality, fire, or explosion) resulting from an earthquake. The airborne released materials were assumed to enter the environment through a leak path factor of 0.10. The material at risk is assumed to be the maximum amount of plutonium that could be in the glovebox at the time of accident.

❒ **Assessment of Air Release Fraction and Respirable Fraction Values for Accident at Los Alamos National Laboratory—**The residue materials processed at Los Alamos National Laboratory are in either powder or liquid slurry form. The airborne release fraction and respirable fraction values for the powder in similar accident scenarios given earlier for Rocky Flats and the Savannah River Site are applied here as well (see Sections D.3.3.3.1 and D.3.3.3.2 and Tables D–24 and D–25). For the liquid slurries, the combined [airborne release fraction]×[respirable fraction] values caused by an earthquake and a fire are estimated based on the data provided in the DOE Handbook (DOE 1994a). For an earthquake, a conservative combined value of 7×10^{-6} for [airborne release fraction]×[respirable fraction] is assigned. For a fire, a value of 6×10^{-5}, which corresponds to the airborne respirable fraction of powder in a fire accident, is assumed.

D.3.3.4 Storage Accident Scenario Descriptions and Source Terms

D.3.3.4.1 Alternative 1 - No Action

Under Alternative 1, the residues and scrub alloy will be stored for a period of 20 years in Rocky Flats Building 371 or in new Butler buildings. For the purpose of this storage analysis it is assumed that two 2,090 m^2 (22,500 ft^2) buildings, with a storage capacity of 11,250 drums per building (i.e., 500 drums per 93 m^2 (1,000 ft^2)), will be constructed in the protected area near Building 707 on previously disturbed land. Since the Butler building location has not been finalized, the EIS accident analysis assumed Building 707 coordinates for the location of releases from the Butler buildings. Following Alternative 1 processing and/or packaging, the plutonium residues and scrub alloy will be stored in either drummed pipe components, drums, 3013 containers, or convenience cans. **Table D–32** presents the storage configuration for Alternative 1.

Table D–32 Alternative 1 Storage

Material	*Quantity*		*Storage*			
			Drummed Pipe Component	*Location*		*Storage Area (ft^2)*
	Pu (kg)	*Drums*		*Butler Building*	*Building 371 Vault*	
Ash Residue	1,150	6,250	Yes	X		12,500
Salt Residue	994	6,509	Yes	X		13,018
Combustible Residue	21.3	916	No	X		1,832
Fluoride Residue	141	141 [a]	No		X	–
	0.4	10	No	X		20
Filter Media Residue	112	4,827	No	X		9,654
Sludge Residue	26.4	1,140	No	X		2,280
Glass Residue	0.06	7	Yes	X		14
Graphite Residue	96.4	575	Yes	X		1,150
Inorganic Residue	17.5	106	Yes	X		212
Scrub Alloy	200	276 [b]	No		X	–

[a] 3013 containers, not drums
[b] Convenience cans, not drums

❒ **Plutonium Residue and Scrub Alloy Vulnerability to Storage Accidents—** A spectrum of storage-related accidents were considered. The accidents were divided into two classes of accidents related to the handling of the drums and containers and accidents related to the storage in facilities. Handling accidents were dropped from further consideration because the consequences and risks of handling accidents are assessed for process-related accidents.

The selection of storage-related accidents considered the vulnerability of the Butler building and Building 371 to a spectrum of accidents. In addition, the robustness of the potential storage containers was also considered when screening accidents for further evaluation. The following representative set of storage-related accidents are evaluated in this EIS for Alternative 1, No Action.

- High Wind
- Large Aircraft Crash into Building
- Small Aircraft Crash into Building
- Room/Vault Fire
- Earthquake and Building Collapse

Table D–33 summarizes the vulnerability of the building and their applicable storage containers to the set of postulated accidents. **Table D–34** summarizes the vulnerability of the processed plutonium residues and scrub alloy in storage to the set of accidents.

Table D–33 Building and Storage Container Vulnerability

Accident	*Butler Building*			*Building 371*		
	Building	*Storage in Drummed Pipe Component*	*Storage in Drum*	*Building Vault*	*Storage in 3013 Container*	*Storage in Convenience Can*
High Wind	Yes	No	Yes	No	No	No
Large Aircraft Crash	Yes	Yes	Yes	Yes	Yes	Yes
Small Aircraft Crash	Yes	No	Yes	No	No	No
Room/Vault Fire	Yes	No	Yes	Yes	No	Yes
Earthquake and Building Collapse	Yes	No	Yes	Yes	Yes	Yes

Table D–34 Processed Plutonium Residue and Scrub Alloy Vulnerability During Storage

Material	*Stored Material Vulnerable to Accident*				
	High Wind	*Small Aircraft Crash*	*Large Aircraft Crash*	*Room/Vault Fire*	*Earthquake and Building Collapse*
Ash Residue [a]	No	No	No	No	No
Salt Residue	No	No	Yes	No	No
Combustible Residue	Yes [b]	Yes [b]	Yes	Yes	Yes [c]
Fluoride Residue [d]	No	No	Yes	No	Yes
Fluoride Residue [e]	Yes [b]	Yes [b]	Yes	Yes	Yes [c]
Filter Media Residue	Yes [b]	Yes [b]	Yes	Yes	Yes [c]
Sludge Residue	Yes [b]	Yes [b]	Yes	Yes	Yes [c]
Glass Residue	No	No	Yes	No	No
Graphite Residue	No	No	Yes	No	No
Inorganic Residue	No	No	Yes	No	No
Scrub Alloy	No	No	Yes	Yes	Yes

[a] Residue is cemented.

[b] The combustible, fluoride, filter media, and sludge residue stored in Butler buildings would not be vulnerable to the effects of the high wind and small aircraft accidents if all combustible, fluoride, filter media, and sludge residue drums were placed in the Butler building storage array configuration such that they were shielded from above and on the outer perimeter of the storage array configuration by drums that contain residue in pipe components. The analysis in this EIS took no credit for strategic placement of combustible, fluoride, filter media, and sludge residue drums in the Butler building storage array configuration.

[c] The combustible, fluoride, filter media, and sludge residue stored in Butler buildings would not be vulnerable to the effects of the earthquake and building collapse accident if all combustible, fluoride, filter media, and sludge residue drums were placed in the Butler building storage array configuration such that they were shielded from above, shielded on the outer perimeter of the storage array configuration, and shielded from building columns located within the storage array by drums that contain residue in pipe components. The analysis in this EIS took no credit for strategic placement of combustible, fluoride, filter media, and sludge residue drums in the Butler building storage array configuration.

[d] Stored in Building 371.

[e] Stored in Butler building.

❒ Accident Scenarios and Source Terms

Wind, Butler Building—The design basis straight wind for Performance Category (PC) 1 buildings at Rocky Flats is 175 km/hr (109 mi/hr) (DOE 1994b). The accident scenario postulated that high winds of 175 km/hr (109 mi/hr) breach the Butler storage buildings. While wind-driven missiles are not within the design basis for PC1 buildings, the scenario postulated that the 175 km/hr (109 mi/hr) wind picks up a 2x4 timber plank and the plank is driven into one of the Butler buildings with enough force to penetrate the building's steel siding. The analysis postulated that the wind-driven plank enters the building and breaches a single drum. Pipe components are not breached by the wind-driven plank. The analysis postulated that a drum containing combustible, fluoride, filter media, or sludge residue was breached and 10% of the contents was spilled. The conditional probability of the plank striking a drum containing either combustible, fluoride, filter media, or sludge residue was considered when estimating the accident risks. The analysis took no credit for strategic placement of combustible, fluoride, filter media, or sludge residue drums in the storage array configuration to reduce the source term. The accident source terms are presented in **Table D–35**.

Table D–35 High Wind Accident Source Term

Residue	*Mar Pu (g)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point*
Combustibles	23.2	0.1	1×10^{-6} [a]	1	2.32×10^{-6}	Ground
Fluoride	40.0	0.1	0.00004 [a]	1	0.00016	Ground
Filter Media	23.2	0.1	1×10^{-6} [a]	1	2.32×10^{-6}	Ground
Sludge	23.2	0.1	0.00004 [b]	1	0.0000928	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] Source: Table D–29.
[b] Dry powder, assumed same as ash.

High Wind, Building 371—High winds and tornado-generated missiles do not damage Building 371 leading to a release (EG&G 1995).

Large Aircraft Crash—Using data derived from upper bound estimates for Building 707, it was determined that the frequency with which a large commercial aircraft and/or a high-powered military aircraft would crash into a Butler storage building was less than 1×10^{-7}. Section D.3.3.3.1 stated that for Building 371, the frequency was also less than 1×10^{-7}. Accidents with a frequency less than 1×10^{-7} are considered not reasonably foreseeable. Since the annual frequency for this accident is in the not reasonably foreseeable range, the accident consequences and risks were not evaluated.

Small (General Aviation) Aircraft Crash, Butler Building—The scenario postulated that: 1) The aircraft engine penetrated the building, up to six drums are breached by the impact of the engine, and a fire results from the aircraft fuel. 2) The aircraft engine would not breach any pipe components. 3) The fire would not cause the breach of additional drums due to the limited availability of combustibles in the Butler building storage area, the small amount of fuel available in the aircraft fuel tanks, the ability of the building's steel walls and roof to remove heat (i.e., transfer outside of building) from the fire, and the large area of the building available to dissipate the heat from the fire.

Only drums containing combustible, fluoride, filter media, and sludge residue are vulnerable to the postulated accident scenario. To assess the maximum consequence for the accident, the analysis assumed that either six combustible residue drums or six fluoride drums or six filter media drums or six sludge

drums were breached by the aircraft engine and the breached drums were involved in the fire. The conditional probability of the aircraft engine striking drums containing either combustible, fluoride, filter media, or sludge residue was considered when estimating the accident risks. The analysis took no credit for strategic placement of combustible, fluoride, filter media, and sludge residue drums in the storage array configuration to reduce the source term. The accident source terms are presented in **Table D–36**.

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Table D–36 Small Aircraft Accident Source Term

Residue	*Mar Pu (g)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point* [c]
Combustibles	139 [a]	1	0.0005 [c]	1	0.0696	Ground
Fluoride	240 [b]	1	1×10^{-6} [c]	1	0.000240	Ground
Filter Media	139 [a]	1	0.00006 [c]	1	0.00835	Ground
Sludge	139 [a]	1	0.00006 [d]	1	0.00835	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] 23.2 g plutonium per drum.
[b] 40.0 g plutonium per drum.
[c] Source: Table D–29
[d] Dry powder, assumed same as ash.
[e] The analysis took no credit for the fire's thermal plume to reduce accident consequences.

Small (General Aviation) Aircraft Crash, Building 371—The aircraft will not penetrate the Building 371.

Room Fire, Butler Building—The scenario postulated a non-mechanistic room fire in the open storage area. Due to the limited availability of combustibles in the Butler building storage area, the ability of the building's steel walls and roof to remove heat (i.e., transfer outside of building) from the fire, and the large area of the building available to dissipate the heat from the fire; the analysis assumed that the fire was very limited and would breach less than 0.1% of the drums in storage. The analysis also assumed that the fire would not breach pipe components. Only drums containing combustible, fluoride, filter media, and sludge residue are vulnerable to the postulated accident scenario. To assess the maximum consequence for the accident, the analysis assumed the combustible, fluoride, filter media, and sludge residue were stored in the same building, one combustible residue drum, one fluoride drum, five filter media drums, and two sludge drums were breached, and the contents of the drums were exposed to the fire. The accident source terms are presented in **Table D–37**.

Table D–37 Butler Building Room Fire Accident Source Term

Residue	*Mar Pu (g)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point*
Combustibles	23.2 [a]	1	0.0005 [c]	1	0.0116	Ground
Fluoride	40.0 [b]	1	1×10^{-6} [c]	1	0.0000400	Ground
Filter Media	116 [a]	1	0.00006 [c]	1	0.00696	Ground
Sludge	46.4 [a]	1	0.00006 [d]	1	0.00278	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] 23.2 g plutonium per drum.
[b] 40.0 g plutonium per drum.
[c] Source: Table D–29
[d] Dry powder, assumed same as ash.

Vault Fire, Building 371—The scenario postulated a fire in the vault area. Due to the limited availability of combustibles in the vault area, the analysis assumed that the fire was very limited and would breach less than 0.1% of the convenience cans in storage. The analysis also assumed that the fire would not breach 3013 inner containers. Only convenience cans containing scrub alloy are vulnerable to the postulated accident scenario. To assess the maximum consequence for the accident, the analysis assumed that one convenience can inner container was breached and the contents exposed to the fire. The accident source term is presented in **Table D–38**.

Table D–38 Building 371 Vault Fire Accident Source Term

Material	*Mar Pu (g)*	*DR* [a]	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point*
Scrub Alloy	725 [b]	0.01	0.00006	0.1	0.0000435	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] For scrub alloy, the ARF value is applied to the surface corrosion; assume 1% of the mass is corroded, or a DR of 0.01. Reference Table D–29.
[b] 725 g plutonium per convenience can.

Earthquake and Butler Building Collapse–The scenario postulated that the earthquake collapsed the Butler storage buildings. Butler buildings have a light-weight structure and it is unlikely that collapse of the building will breach any of the drums. However for the purpose of this EIS, the analysis conservatively postulated that falling structural elements breached 1% of the drums. Pipe components in breached drums were not breached. The analysis also postulated that 10% of the combustible, fluoride, filter media, and sludge residue spilled out of the breached drums and were released. The analysis took no credit for strategic placement of combustible, fluoride, filter media, and sludge residue drums in the storage array configuration to reduce the accident source term. The accident source term is presented in **Table D–39**.

Table D–39 Earthquake and Butler Building Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
Combustibles	21.3	0.01×0.1	0.000193	1	0.00411	Ground
Fluoride	0.4	0.01×0.1	0.000232	1	0.0000928	Ground
Filter Media	112	0.01×0.1	0.000193	1	0.0216	Ground
Sludge	26.4	0.01×0.1	0.000232 [b]	1	0.00612	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction
RF = respirable release fraction LPF = leak path factor
[a] The ARF×RF product for a spill is assumed equivalent to a dock spill. The ARF×RF product does not include the potential for resuspension of particulates after an earthquake. A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.
[b] Dry powder, assume same as ash.

Earthquake and Building 371 Collapse—The scenario postulated that the earthquake collapsed Building 371. The analysis conservatively postulated that 100% of the convenience cans and 1% of the 3013 containers were breached by the falling building debris. The accident source term is presented in **Table D–40**.

Table D–40 Earthquake and Building 371 Collapse Accident Source Term

Material	*Mar Pu (kg)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point*
Fluoride Residue	141	0.01	0.000792	0.1	0.112	Ground
Scrub Alloy	200	0.01 [a]	0.000292	0.1	0.0584	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] For scrub alloy, the ARF value is applied to the surface corrosion; assume 1% of the mass is corroded, or a DR of 0.01. Reference Table D–29.

❒ **Accident Frequency—** Accident frequencies were derived for each of the accidents. For the Butler Building high wind and small aircraft crash accidents, the building accident frequency was apportioned on units of storage area to calculate the frequency of a wind-driven missile or an aircraft impacting a specific cluster of storage drums. The analysis assumed residues would be processed, if necessary, and packaged on a campaign basis and stored as a cluster of drums in the storage area rather than being randomly dispersed throughout the facility. **Table D–41** presents the accident frequency for each of the storage buildings. **Table D–42** breaks down the accident frequency by the category of stored material.

Table D–41 Accident Frequency by Storage Building

Accident	*Accident Frequency (per year)*	
	Butler Building	*Building 371*
High Wind	0.02 (DOE 1994b) 4.44×10^{-7}/ft^2 of storage area [a]	N/A
Large Aircraft Crash	1×10^{-8}/building [b]	less than 1×10^{-7} [c]

Accident	*Accident Frequency (per year)*	
	Butler Building	***Building 371***
Small Aircraft Crash	3×10^{-6}/building [b] 1.33×10^{-10}/ft^2 of storage area	0.00004 [c]
Room/Vault Fire	0.00001/building [d]	1×10^{-6} (CID 1997) [e]
Earthquake and Building Collapse	0.002 (CID 1997)	0.000094 [c]

N/A = Not applicable.
[a] Wind-driven missile impacts a drum in storage area.
[b] Derived from upper bound estimates for Building 707 presented in Section D.3.3.3.1.
[c] Source: Section D.3.3.3.1.
[d] Estimated one order of magnitude more likely than a special nuclear material (SNM) vault fire.
[e] SNM vault fire.

Table D–42 Accident Frequency for Storage of Plutonium Residues and Scrub Alloy

Material	*Accident Annual Frequency*				
	High Wind	***Small Aircraft Crash***	***Large Aircraft Crash***	***Room/Vault Fire***	***Earthquake and Building Collapse***
Ash Residue	N/A	N/A	N/A	N/A	N/A
Salt Residue	N/A	N/A	N/A	N/A	N/A
Combustible Residue	0.000813	2.44×10^{-7}	N/A	0.00001	0.002
Fluoride Residue Stored in Bldg. 371	N/A	N/A	N/A	N/A	0.000094
Fluoride Residue Stored in Butler Bldg.	8.89×10^{-6}	2.67×10^{-9}	N/A	0.00001	0.002
Filter Media Residue	0.00429	1.29×10^{-6}	N/A	0.00001	0.002
Sludge Residue	0.00101	3.03×10^{-7}	N/A	0.00001	0.002
Glass Residue	N/A	N/A	N/A	N/A	N/A
Graphite Residue	N/A	N/A	N/A	N/A	N/A
Inorganic Residue	N/A	N/A	N/A	N/A	N/A
Scrub Alloy	N/A	N/A	N/A	1×10^{-6}	0.000094

N/A = not applicable

D.3.3.4.2 Alternative 2 – Processing Without Plutonium Separation

Following processing of plutonium residues and scrub alloy at Rocky Flats using Alternative 2 processing technologies, the processed material is packaged in pipe components and drummed prior to movement to an interim storage area or staging area for shipment to WIPP. For the purpose of this EIS, the analysis assumed that the packaged material will be stored in Butler Buildings similar to those described in Section D.3.3.4.1. **Table D–43** presents the storage configuration for each Alternative 2 process technology.

Table D–43 Alternative 2 Storage

Material	*Process Technology*	*Storage*		
		Drummed Pipe Component	*Location*	
			Butler Building	*Building 371 Vault*
Ash Residue	Calcination/Vitrification	Yes	X	
	Blend Down	Yes	X	
	Cold Ceramification	Yes	X	
Salt Residue	Blend Down	Yes	X	
Combustible Residue	Blend Down	Yes	X	
	Catalytic Chemical Oxidation	Yes	X	
	Sonic Wash	Yes	X	
Fluoride Residue	Blend Down	Yes	X	
Filter Media Residue	Calcination/Vitrification	Yes	X	
	Blend Down	No [a]	X	
	Sonic Wash	Yes	X	

Material	*Process Technology*	*Storage*		
		Drummed Pipe Component	*Location*	
			Butler Building	*Building 371 Vault*
Sludge Residue	Calcination/Vitrification	Yes	X	
	Blend Down	Yes	X	
Glass Residue	Calcination/Vitrification	Yes	X	
	Blend Down	Yes	X	
	Sonic Wash	Yes	X	
Graphite Residue	Calcination/Vitrification	Yes	X	
	Blend Down	Yes	X	
	Cementation	Yes	X	
Inorganic Residue	Calcination/Vitrification	Yes	X	
	Blend Down	Yes	X	
Scrub Alloy	Calcination/Vitrification	Yes	X	

[a] Stored in drummed convenience can.

❒ **Plutonium Residue and Scrub Alloy Vulnerability to Storage Accidents -** The same spectrum of storage-related accidents discussed in Section D.3.3.4.1 were considered.

Table D–44 summarizes the vulnerability of the Butler building and the drummed pipe components to the set of postulated accidents. **Table D–45** summarizes the vulnerability of the processed plutonium residues and scrub alloy in storage to the set of accidents. As discussed in Section D.3.3.4.1, the annual frequency for the large aircraft crash is in the not reasonably foreseeable range and the accident consequences are not evaluated.

Table D–44 Butler Building and Storage Container Vulnerability

Accident	*Vulnerability*		
	Butler Building	*Material Stored in Drummed Pipe Component*	*Material Stored in Drummed Convenience Can*
High Wind	Yes	No	Yes
Small Aircraft Crash	Yes	No	Yes
Room Fire	Yes	No	Yes
Earthquake and Building Collapse	Yes	No	Yes

Table D–45 Processed Plutonium Residue and Scrub Alloy Vulnerability During Storage

Material	*Stored Material Vulnerable to Accident*			
	High Wind	*Small Aircraft Crash*	*Room Fire*	*Earthquake and Building Collapse*
Ash Residue	No	No	No	No
Salt Residue	No	No	No	No
Combustible Residue	No	No	No	No
Fluoride Residue	No	No	No	No
Filter Media Residue	Yes [a]	Yes [a]	Yes [a]	Yes [a]
Sludge Residue	No	No	No	No
Glass Residue	No	No	No	No
Graphite Residue	No	No	No	No
Inorganic Residue	No	No	No	No
Scrub Alloy	No	No	No	No

[a] Filter media residue processed using the blend down technology.

❒ **Accident Scenarios and Source Terms—** Table D–44 and Table D–45 indicate that only filter media residue processed using the blend down technology is vulnerable to the postulated set of accidents. 112 kg of residue will be stored in 4,787 drums.

High Wind, Butler Building—The analysis postulated that a drum containing filter media residue was breached and 10% of the contents was spilled. The conditional probability of the plank striking a drum containing filter media residue was considered when estimating the accident risks. The analysis took no credit for strategic placement of filter media residue drums in the storage array configuration to reduce the source term. The accident source terms are presented in **Table D–46.**

Table D–46 High Wind Accident Source Term

Residue	*MAR Pu (g)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point*
Filter Media	23.2	0.1	1×10^{-6} [a]	1	2.32×10^{-6}	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] Source: Table D–29.

Small (General Aviation) Aircraft Crash, Butler Building–The analysis assumed that six filter media drums were breached by the aircraft engine and the breached drums were involved in the fire. The conditional probability of the aircraft engine striking drums containing filter media residue was considered when estimating the accident risks. The analysis took no credit for strategic placement of filter media residue drums in the storage array configuration to reduce the source term. The accident source terms are presented in **Table D–47.**

Table D–47 Small Aircraft Accident Source Term

Residue	*MAR Pu (g)*	*DR*	*ARFxRF*	*LPF*	*Source Term Pu (g)*	*Release Point* [c]
Filter Media	139 [a]	1	0.00006 [b]	1	0.00835	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] 23.2 g plutonium per drum.
[b] Source: Table D–29
[c] The analysis took no credit for the fire's thermal plume to reduce accident consequences.

Room Fire, Butler Building—The analysis assumed five filter media drums were breached and the contents of the drums were exposed to the fire. The accident source terms are presented in **Table D–48**.

Table D–48 Butler Building Room Fire Accident Source Term

Residue	*MAR Pu (g)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point*
Filter Media	116 [a]	1	0.00006 [b]	1	0.00696	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] 23.2 g plutonium per drum.
[b] Source: Table D–29.

Earthquake and Butler Building Collapse—The analysis postulated that 10% of the filter media residue spilled out of the breached drums and were released. The analysis took no credit for strategic placement of filter media residue drums in the storage array configuration to reduce the accident source term. The accident source term is presented in **Table D–49**.

Table D–49 Earthquake and Butler Building Collapse Accident Source Term

Residue	*MAR Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
Filter Media	112	0.01×0.1	0.000193	1	0.0216	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] The ARF×RF product for a spill is assumed equivalent to a dock spill. The ARF×RF product does not include the potential for resuspension of particulates after an earthquake. A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.

❒ **Accident Frequency—** Accident frequencies presented in **Table D-50** were derived using Table D-41.

Table D–50 Accident Frequency for Storage of Filter Media Residue Processed Using the Blend Down Technology

	Accident Annual Frequency				
Material	*High Wind*	*Small Aircraft Crash*	*Large Aircraft Crash*	*Room/Vault Fire*	*Earthquake and Building Collapse*
Filter Media Residue	0.00429	1.29×10^{-6}	N/A	0.00001	0.002

D.3.3.4.3 Alternative 3 – Processing With Plutonium Separation

Plutonium residues and scrub alloy can be processed using Alternative 3 process technologies at Rocky Flats, the Savannah River Site, and the Los Alamos National Laboratory. The processing of plutonium residues and scrub alloy at the Savannah River Site or the Los Alamos National Laboratory requires preprocessing and/or packaging at Rocky Flats. Alternative 3 storage assessments address the following issues:

- storage after processing with plutonium separation at Rocky Flats,
- storage at Rocky Flats after preprocessing and/or packaging for offsite processing at the Savannah River Site or the Los Alamos National Laboratory,
- storage after processing with plutonium separation at the Savannah River Site, and
- storage after processing with plutonium separation at the Los Alamos National Laboratory.

Table D–51 presents the storage configuration for each Alternative 3 process technology.

Table D–51 Alternative 3 Storage

		Quantity		*Storage Location*				
Material	***Process Technology***	***Pu (kg)***	***Storage Containers***	***RF Butler Bldg.***	***RF Bldg. 371 Vault***	***SRS APSF Vault***	***LANL TA-55 Storage***	***LANL TA-55 Vault***
Ash Residue	Preprocess at RF and Purex at SRS (Incinerator Ash)	890	3,475 [a]		X			
		890	[b]			X		
	Preprocess at RF and MEO at SRS (Incinerator Ash and Graphite Fines)	974	2,740 [a]		X			
		974	[b]			X		
	Preprocess at RF and Purex at SRS (SS&C)	128	760 [a]		X			
		128	[b]			X		
Salt Residue	Salt Distillation at RF (ER & MSE)	804	269 [b]		X			
	Preprocess at RF and Salt Distillation at LANL (ER & MSE)	804	1,885 [a]		X			
		792	264 [b]					X
		12.3	338 [d]				X	
	Water Leach at RF (ER & MSE)	780	223 [a]		X			
		24	126 [c]	X				
	Water Leach at RF (DOR)	182	52 [b]		X			
		6	31 [c]	X				
	Preprocess at RF and Water Leach at LANL (DOR)	188	459 [a]		X			
		188	47 [b]					X
	Preprocess at RF and Acid Dissolution at LANL (DOR)	188	459 [a]		X			
		188	188 [b]					X
		0.7	162 [d]				X	
	Salt Scrub at RF and Purex at SRS	964	986 [e]		X			
		28	408 [d]	X				

Material	*Process Technology*	*Quantity*		*Storage Location*				
		Pu (kg)	*Storage Containers*	*RF Butler Bldg.*	*RF Bldg. 371 Vault*	*SRS APSF Vault*	*LANL TA-55 Storage*	*LANL TA-55 Vault*
		964	[b]			X		
Combustible Residue	MEO at RF	0.1	53 [f]	X				
		20.9	7 [b]		X			
Fluoride Residue	Acid Dissolution at RF	0.4	10 [g]	X				
		141	141 [b]		X			
	Preprocess at RF and Purex at SRS	141	188 [a]		X			
		141	[b]			X		
Filter Media Residue	MEO at RF	1	129 [f]	X				
		109	37 [b]		X			
Sludge Residue	Acid Dissolution at RF	0.1	19 [g]	X				
		25.3	26 [b]		X			
Glass Residue	MEO at RF	0.1	7 [f]	X				
		4.9	2 [b]		X			
Graphite Residue	MEO at RF	0.1	104 [f]	X				
		95.3	32 [b]		X			
	Preprocess at RF and MEO at SRS	96.4	470 [a]		X			
		96.4	[b]			X		
Inorganic Residue	MEO at RF	0.2	23 [f]	X				
		17.1	6 [b]		X			
	Preprocess at RF and MEO at SRS	17.5	111 [a]		X			
		17.5	[b]			X		
Scrub Alloy	Preprocess at RF and Purex at SRS	200	200 [e]		X			
		200	[b]			X		

MEO = mediated electrochemical oxidation SRS = Savannah River Site RF = Rocky Flats Environmental Technology Site
LANL = Los Alamos National Laboratory TA = technical area APSF = Actinide Packaging and Storage Facility
DOR = direct oxide reduction salt residue ER & MSE = electrorefining and molten salt extraction salt residue
SS&C = sand, slag, and crucible ash residue
[a] 9975 containers
[b] 3013 containers
[c] 8802 container and convenience can drummed
[d] Drummed pipe components
[e] 6M containers
[f] Cemented and drummed
[g] Convenience cans drummed.

❒ **Storage After Processing With Plutonium Separation at Rocky Flats—Table D–52** identifies storage configuration for the residues stored at Rocky Flats following the processing, using Alternative 3 plutonium separation technologies, and packaging.

Table D–52 Alternative 3 Storage After Processing at Rocky Flats

Material	*Quantity Pu (kg)*	*Storage Container*	*Storage Location*	
			Butler Building	*Building 371 Vault*
Ash Residue	0	N/A		
ER & MSE Salt Residue	780	9975 Container		X
	24	8802 Container and Convenience Can Drummed	X	
DOR Salt Residue	182	9975 Container		X
	6	8802 Container and Convenience Can Drummed	X	
Combustible Residue	0.1	Cemented and Drummed	X	
	20.9	3013 Container		X
Fluoride Residue	0.4	Convenience Cans Drummed	X	
	141	3013 Container		X
Filter Media Residue	1	Cemented and Drummed	X	
	109	3013 Container		X
Sludge Residue	0.1	Convenience Cans Drummed	X	
	25.3	3013 Container		X
Glass Residue	0.1	Cemented and Drummed	X	
	4.9	3013 Container		X
Graphite Residue	0.1	Cemented and Drummed	X	
	95.3	3013 Container		X
Inorganic Residue	0.2	Cemented and Drummed	X	
	17.1	3013 Container		X
Scrub Alloy	0	N/A		

DOR = direct oxide reduction salt residue ER & MSE = electrorefining and molten salt extraction salt residue
N/A = not applicable.

Plutonium Residue Vulnerability to Storage Accidents—The same set of storage-related accidents discussed in Section D.3.3.4.1 were considered. **Table D–53** summarizes the vulnerability of the building and their applicable storage containers to the set of postulated accidents and **Table D–54** summarizes the vulnerability of the processed plutonium residues in storage to the set of accidents. As discussed in Section D.3.3.4.1, the annual frequency for the large aircraft crash at Rocky Flats is in the not reasonably foreseeable range and the accident consequences are not evaluated.

Table D–53 Building Storage Container Vulnerability

Accident	*Butler Building*			*Building 371 Vault*	
	Storage in Drummed 8802 Container and Convenience Can	*Storage in Drummed Convenience Can*	*Cemented Residue Storage in Drum*	*Storage in 3013 Container*	*Storage in 9975 Container*
High Wind	Yes	Yes	No	No	No
Small Aircraft Crash	Yes	Yes	No	No	No
Room/Vault Fire	Yes	Yes	No	No	No
Earthquake and Building Collapse	Yes	Yes	No	Yes	Yes

Table D–54 Processed Plutonium Residue Vulnerability During Storage

Material	*Location*	*Stored Material Vulnerable to Accident*			
		High Wind	*Small Aircraft Crash*	*Room/Vault Fire*	*Earthquake and Building Collapse*
Ash Residue	N/A	–	–	–	–
Salt Residue	Butler Bldg.	Yes	Yes	Yes	Yes
	Bldg. 371 Vault	No	No	No	Yes
Combustible Residue	Butler Bldg.	No	No	No	No
	Bldg. 371 Vault	No	No	No	Yes
Fluoride Residue	Butler Bldg.	Yes	Yes	Yes	Yes
	Bldg. 371 Vault	No	No	No	Yes
Filter Media Residue	Butler Bldg.	No	No	No	No
	Bldg. 371 Vault	No	No	No	Yes
Sludge Residue	Butler Bldg.	Yes	Yes	Yes	Yes
	Bldg. 371 Vault	No	No	No	Yes
Glass Residue	Butler Bldg.	No	No	No	No
	Bldg. 371 Vault	No	No	No	Yes
Graphite Residue	Butler Bldg.	No	No	No	No
	Bldg. 371 Vault	No	No	No	Yes
Inorganic Residue	Butler Bldg.	No	No	No	No
	Bldg. 371 Vault	No	No	No	Yes
Scrub Alloy	N/A	–	–	–	–

N/A = not applicable

Accident Scenarios and Source Terms—The accident scenarios are described in Section D.3.3.4.1.

High Wind, Butler Building—The analysis postulated that a drum containing salt, or fluoride, or sludge residues was breached and 10% of the contents was spilled. The accident source terms are presented in **Table D–55**.

Table D–55 High Wind Accident Source Term

Residue	*Mar Pu (g)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point*
ER & MSE Salt	188	0.1	8×10^{-8} [a]	1	1.50×10^{-6}	Ground
DOR Salt	194	0.1	8×10^{-8} [a]	1	1.55×10^{-6}	Ground
Fluoride	39.6	0.1	0.00004 [a]	1	0.000158	Ground
Sludge	5.3	0.1	0.00004 [b]	1	0.0000212	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction

LPF = leak path factor DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue
[a] Source: Table D–29
[b] Source: Table D–29, residue was calcinated. Dry powder, assumed same as ash.

High Wind, Building 371—The postulated wind-driven missile will not penetrate Building 371.

Small (General Aviation) Aircraft Crash, Butler Building—To assess the maximum consequence for the accident, the analysis assumed that either six salt residue drums, six fluoride residue drums, or six sludge residue drums were breached by the aircraft engine and the breached drums were involved in the fire. The accident source terms are presented in **Table D–56**.

Table D–56 Small Aircraft Accident Source Term

Residue	*Mar Pu (g)*	*DR*	*ARF×RF*	*LPF*	*Source Term Pu (g)*	*Release Point* [c]
ER & MSE Salt	1,128	1	0.00006 [a]	1	0.0677	Ground
DOR Salt	1,164	1	0.00006 [a]	1	0.0698	Ground
Fluoride	238	1	1.0×10^{-6} [a]	1	0.000238	Ground
Sludge	31.8	1	0.00006 [b]	1	0.00191	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue
[a] Source: Table D–29
[b] Source: Table D–29, residue was calcinated.
[c] The analysis took no credit for the fire's thermal plume to reduce accident consequences.

Small (General Aviation) Aircraft Crash, Building 371—The aircraft will not penetrate the Building 371.

Room Fire, Butler Building—To assess the maximum consequence for the accident, the analysis assumed the salt, fluoride, and sludge residues were stored in the same building; one salt residue drum, one fluoride residue drum, and one sludge residue drum were breached; and the contents of the drums were exposed to the fire. The accident source terms are presented in **Table D–57**.

Table D–57 Butler Building Room Fire Accident Source Term

Residue	*Mar Pu (g)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
DOR Salt	194	1	0.00006 [a]	1	0.0116	Ground
Fluoride	39.6	1	1.0×10^{-6} [a]	1	0.0000396	Ground
Sludge	5.3	1	0.00006 [b]	1	0.000318	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor
[a] Source: Table D–29.
[b] Source: Table D–29, residue was calcinated. Dry powder, assumed same as ash.

Vault Fire, Building 371—No storage containers would be breached by the fire.

Earthquake and Butler Building Collapse—The accident scenario is described in Section D.3.3.4.1. The analysis postulated that 10% of the salt, fluoride, and sludge residues spilled out of the breached drums and were released. The accident source term is presented in **Table D–58**.

Table D–58 Earthquake and Butler Building Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
ER & MSE Salt	24	0.01×0.1	0.000192 [a]	1	0.00461	Ground
DOR Salt	6	0.01×0.1	0.000192 [a]	1	0.00115	Ground
Fluoride	0.4	0.01×0.1	0.000232 [b]	1	0.0000928	Ground
Sludge	0.1	0.01×0.1	0.000232 [b,c]	1	0.0000232	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue
[a] The ARF×RF product for a spill is 8×10^{-8} (spill assumed equivalent to a dock spill). The ARF×RF product does not include the potential for resuspension of particulates after an earthquake. A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.
[b] The ARF×RF product for a spill is 0.00004 (spill assumed equivalent to a dock spill). The ARF×RF product does not include the potential for resuspension of particulates after an earthquake. A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.
[c] Source: Table D–29, residue was calcinated. Dry powder, assumed same as ash.

Earthquake and Building 371 Collapse—The scenario postulated that the earthquake collapsed Building 371. The analysis conservatively postulated that 1% of the 3013 containers and 0.1% of the 9975 containers were breached by the falling building debris. The 9975 container construction is much more robust than the 3013 containers. The accident source term is presented in **Table D–59**.

Table D–59 Earthquake and Building 371 Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
ER & MSE Salt	780	0.001	0.000792	0.1	0.0618	Ground
DOR Salt	182	0.001	0.000792	0.1	0.0144	Ground
Combustible	20.9	0.01	0.000292	0.1	0.00610	Ground
Fluoride	141	0.01	0.000792	0.1	0.112	Ground
Filter Media	109	0.01	0.000792	0.1	0.0863	Ground
Sludge	25.3	0.01	0.000792	0.1	0.0200	Ground
Glass	4.9	0.01	0.000292	0.1	0.00143	Ground
Graphite	95.3	0.01	0.000292	0.1	0.0278	Ground
Inorganic	17.1	0.01	0.000292	0.1	0.00499	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue
[a] A resuspension value of 0.000192 needs to be added to all ARFxRF values. Reference Table D–29.

Accident Frequency— Accident frequencies were derived using Table D–41. **Table D–60** breaks down the accident frequency by the building and category of stored material.

Table D–60 Accident Frequency for Storage of Plutonium Residues

Residue	*Location*	*Accident Annual Frequency*			
		High Wind	*Small Aircraft Crash*	*Room/Vault Fire*	*Earthquake and Building Collapse*
ER & MSE Salt	Butler Bldg.	0.000112	3.35×10^{-8}	0.00001	0.002
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
DOR Salt	Butler Bldg.	0.0000275	8.25×10^{-9}	0.00001	0.002
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
Combustible	Butler Bldg.	N/A	N/A	N/A	N/A
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
Fluoride	Butler Bldg.	8.88×10^{-6}	2.66×10^{-9}	0.00001	0.002
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
Filter Media	Butler Bldg.	N/A	N/A	N/A	N/A
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
Sludge	Butler Bldg.	0.0000169	5.05×10^{-9}	0.00001	0.002
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
Glass	Butler Bldg.	N/A	N/A	N/A	N/A
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
Graphite Residue	Butler Bldg.	N/A	N/A	N/A	N/A

Residue	*Location*	*Accident Annual Frequency*			
		High Wind	*Small Aircraft Crash*	*Room/Vault Fire*	*Earthquake and Building Collapse*
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094
Inorganic	Butler Bldg.	N/A	N/A	N/A	N/A
	Bldg. 371 Vault	N/A	N/A	N/A	0.000094

N/A = not applicable

❒ **Storage at Rocky Flats After Preprocessing and/or Repackaging for Offsite Processing—Table D–61** presents the storage configuration for the residues and scrub alloy stored at Rocky Flats following preprocessing and packaging of the material to be processed at the Savannah River Site or the Los Alamos National Laboratory using Alternative 3 plutonium separation process technologies.

Table D–61 Alternative 3 Storage at Rocky Flats After Preprocessing for Offsite Processing

Material	*Quantity Pu (kg)*	*Storage Container*	*Storage Location*	
			Butler Building	*Building 371 Vault*
Ash Residue	1,102	9975 Container		X
Salt Residue	964	6M Container		X
	28	Drummed Pipe Component	X	
Combustible Residue	0	N/A		
Fluoride Residue	141	9975 Container		X
Filter Media Residue	0	N/A		
Sludge Residue	0	N/A		
Glass Residue	0	N/A		
Graphite Residue	96.4	9975 Container		X
Inorganic Residue	17.5	9975 Container		X
Scrub Alloy	200	6M Container		X

N/A = not applicable

Plutonium Residue and Scrub Alloy Vulnerability to Storage Accidents—The same set of storage-related accidents discussed in Section D.3.3.4.1 were considered. **Table D–62** summarizes the vulnerability of the building and their applicable storage containers to the set of postulated accidents and **Table D–63** summarizes the vulnerability of the preprocessed plutonium residues in storage to the set of accidents. As discussed in Section D.3.3.4.1, the annual frequency for the large aircraft crash at Rocky Flats is in the not reasonably foreseeable range and the accident consequences are not evaluated.

Table D–62 Building Storage Container Vulnerability

Accident	Butler Building	Building 371 Vault	
	Storage in Drummed Pipe Component	Storage in 6M Container	Storage in 9975 Container
High Wind	No	No	No
Small Aircraft Crash	No	No	No
Room/Vault Fire	No	No	No
Earthquake and Building Collapse	No	Yes	Yes

Table D–63 Preprocessed Plutonium Residue and Scrub Alloy Vulnerability During Storage

Material	Location	Stored Material Vulnerable to Accident			
		High Wind	Small Aircraft Crash	Room/Vault Fire	Earthquake and Building Collapse
Ash Residue	Bldg. 371 Vault	No	No	No	Yes
Salt Residue	Butler Bldg.	No	No	No	No
	Bldg. 371 Vault	No	No	No	Yes
Combustible Residue	N/A	–	–	–	–
Fluoride Residue	Bldg. 371 Vault	No	No	No	Yes
Filter Media Residue	N/A	–	–	–	–
Sludge Residue	N/A	–	–	–	–
Glass Residue	N/A	–	–	–	–
Graphite Residue	Bldg. 371 Vault	No	No	No	Yes
Inorganic Residue	Bldg. 371 Vault	No	No	No	Yes
Scrub Alloy	Bldg. 371 Vault	No	No	No	Yes

N/A = not applicable

Accident Scenarios and Source Terms—The accident scenarios are described in Section D.3.3.4.1.

High Wind, Butler Building—The postulated wind-driven missile will not penetrate pipe components.

High Wind, Building 371—The postulated wind-driven missile will not penetrate Building 371.

Small (General Aviation) Aircraft Crash, Butler Building—The aircraft will not penetrate pipe components.

Small (General Aviation) Aircraft Crash, Building 371—The aircraft will not penetrate Building 371.

Room Fire, Butler Building—No pipe containers would be breached by the fire.

Vault Fire, Building 371—No storage containers would be breached by the fire.

Earthquake and Butler Building Collapse—No pipe containers would be breached by the earthquake.

Earthquake and Building 371 Collapse—The scenario postulated that the earthquake collapsed Building 371. The analysis conservatively postulated that 0.1% of the 6M and 9975 containers were breached by the falling building debris. 6M and 9975 containers have very robust structural designs. The accident source term is presented in **Table D–64**.

Table D–64 Earthquake and Building 371 Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
Ash	1,102	0.001	0.000792	0.1	0.0873	Ground
ER & MSE Salt	847	0.001	0.000792	0.1	0.0671	Ground
DOR Salt	117	0.001	0.000792	0.1	0.00927	Ground
Fluoride	141	0.001	0.000792	0.1	0.0112	Ground
Graphite	96.4	0.001	0.000292	0.1	0.00281	Ground
Inorganic	17.5	0.001	0.000292	0.1	0.000511	Ground
Scrub Alloy	200	0.001×0.01 [b]	0.000292	0.1	0.0000584	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue
[a] A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.
[b] For scrub alloy, the ARF value is applied to the surface corrosion; assume one percent of the mass is corroded, or a DR = 0.01. Reference Table D–29.

❒ **Storage After Processing With Plutonium Separation at the Savannah River Site—Table D–65** identifies storage configuration for the residues and scrub alloy stored in the APSF vault following the processing and packaging of the material using Alternative 3 plutonium separation technologies in either the F-Canyon or the H-Canyon. When the material is processed in the F-Canyon, the stored product is in the form of plutonium metal. When the material is processed in the H-Canyon, the stored product is in the form of plutonium oxide powder.

Table D–65 Alternative 3 Storage with Processing at the Savannah River Site

Material	*Quantity Pu (kg)*	*Storage Container*	*Storage in APSF Vault*
Ash Residue	1,102	3013 Container	X
Salt Residue	964	3013 Container	X
Combustible Residue	0	N/A	
Fluoride Residue	141	3013 Container	X
Filter Media Residue	0	N/A	
Sludge Residue	0	N/A	
Glass Residue	0	N/A	
Graphite Residue	96.4	3013 Container	X
Inorganic Residue	17.5	3013 Container	X
Scrub Alloy	200	3013 Container	X
Total	2,521	3013 Container	X

APSF = Actinide Packaging and Storage Facility N/A = not applicable

Plutonium Residue and Scrub Alloy Vulnerability to Storage Accidents—The same set of storage-related accidents discussed in Section D.3.3.4.1 were considered. **Table D–66** summarizes the vulnerability of the building and their applicable storage containers to the set of postulated accidents and **Table D–67** summarizes the vulnerability of the processed plutonium residues in storage to the set of accidents.

Table D–66 APSF Vault and 3013 Storage Container Vulnerability

Accident	*APSF Vault*
	Storage in 3013 Container
High Wind	No
Large Aircraft Crash	Yes
Small Aircraft Crash	No
Vault Fire	No
Earthquake and Building Collapse	Yes

APSF = Actinide Packaging and Storage Facility

Table D–67 Canyon Product Vulnerability During Storage

Material	*Location*	*Stored Material Vulnerable to Accident*				
		High Wind	*Small Aircraft Crash*	*Large Aircraft Crash*	*Room/Vault Fire*	*Earthquake and Building Collapse*
F-Canyon Product (Plutonium metal)	APSF Vault	No	No	Yes	No	Yes
H-Canyon Product (Plutonium oxide)	APSF Vault	No	No	Yes	No	Yes

APSF = Actinide Packaging and Storage Facility

Accident Scenarios and Source Terms— The accident scenarios are described in Section D.3.3.4.1.

High Wind—The APSF vault construction will be very robust. The postulated wind-driven missile will not penetrate the APSF vault.

Large Aircraft Crash—The accident frequency is less than a large aircraft crash accident with the F-Canyon. Since the annual frequency for the F-Canyon large aircraft crash accident is in the not reasonably foreseeable range, the accident consequences were not evaluated for the APSF vault large aircraft crash accident.

Small (General Aviation) Aircraft Crash—The APSF vault construction will be very robust. The aircraft will not penetrate the APSF vault.

Vault Fire—No storage containers would be breached by the fire.

Earthquake and APSF Collapse—The scenario postulated that the earthquake collapsed the APSF. The analysis conservatively postulated that 1% of the 3013 containers were breached by the falling building debris. The accident source term is presented in **Table D–68**.

Table D–68 Earthquake and APSF Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
F-Canyon Product (Plutonium metal)	2,521	0.01×0.001 [b]	0.000292	0.1	0.000736	Ground
H-Canyon Product (Plutonium oxide powder)	2,521	0.01	0.000792	0.1	2.00	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor APSF = Actinide Packaging and Storage Facility
[a] A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.
[b] The ARF value in Table D–29 is applied to the surface corrosion and assumed one percent of the mass is corroded for aged scrub alloy. The surface corrosion on processed plutonium metal. stored in a sealed 3013 container would be significantly better than the condition of material at Rocky Flats. Assume an order of magnitude improvement and a DR = 0.001.

Accident Frequency—In accordance with DOE-STD-1020-94 (DOE 1994b), the APSF design is for a performance category (PC) 3 structure with an evaluation basis earthquake of 0.3 g. Beyond evaluation basis earthquake (BEBE) studies have shown that PC3 facilities have adequate margins built into the design so that the building will not collapse during a 0.5 g BEBE. (LANL 1996) For the purpose of this EIS it was conservatively assumed that a 0.5 g BEBE would collapse the APSF vault. Based on extrapolated data from DOE-EH-0529 (DOE 1996c), the return frequency for a 0.5 g BEBE near the APSF site is estimated at 0.00001 per year.

❒ **Storage After Processing With Plutonium Separation at the Los Alamos National Laboratory—** **Table D–69** identifies storage configuration for the residues and scrub alloy stored in the TA-55 plutonium vault following the processing and packaging of the material using Alternative 3 plutonium separation technologies.

Table D–69 Alternative 3 Storage with Processing at the Los Alamos National Laboratory

Material	*Quantity Pu (kg)*	*Storage Container*	*Storage in TA-55 Pu Vault*	*Storage in TA-55*
Ash Residue	0	N/A		
ER & MSE Salt Residue	792	3013 Container	X	
	12.3	Drummed Pipe Components		X
DOR Salt Residue	188	3013 Container	X	
Combustible Residue	0	N/A		
Fluoride Residue	0	N/A		
Filter Media Residue	0	N/A		
Sludge Residue	0	N/A		
Glass Residue	0	N/A		

Material	*Quantity Pu (kg)*	*Storage Container*	*Storage in TA-55 Pu Vault*	*Storage in TA-55*
Graphite Residue	0	N/A		
Inorganic Residue	0	N/A		
Scrub Alloy	0	N/A		

TA = technical area N/A = not applicable DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue.

Plutonium Residue Vulnerability to Storage Accidents—The same set of storage-related accidents discussed in Section D.3.3.4.1 were considered. **Table D–70** summarizes the vulnerability of the building and their applicable storage containers to the set of postulated accidents and **Table D–71** summarizes the vulnerability of the processed salt residues in storage to the set of accidents.

Table D–70 TA-55 Plutonium Residue Storage Container Vulnerability

	TA-55 Plutonium Vault	*TA-55*
Accident	*Storage in 3013 Container*	*Drummed Pipe Component*
High Wind	No	No
Large Aircraft Crash	Yes	Yes
Small Aircraft Crash	No	No
Vault Fire	No	No
Earthquake and Building Collapse	Yes	Yes

TA = technical area DOR = direct oxide reduction salt ER & MSE = electrorefining and molten salt extraction salt

Table D–71 Processed Salt Residue Product Vulnerability During Storage

		Stored Material Vulnerable to Accident				
Material	*Location*	*High Wind*	*Small Aircraft Crash*	*Large Aircraft Crash*	*Room/Vault Fire*	*Earthquake and Building Collapse*
ER & MSE Salt	TA-55 Plutonium Vault	No	No	Yes	No	Yes
	TA-55	No	No	Yes	No	Yes
DOR Salt	TA-55 Plutonium Vault	No	No	Yes	No	Yes

TA = technical area DOR = direct oxide reduction salt ER & MSE = electrorefining and molten salt extraction salt

Accident Scenarios and Source Terms—The accident scenarios are described in Section D.3.3.4.1.

High Wind, Vault Storage—The TA-55 plutonium vault construction is very robust. The postulated wind-driven missile will not penetrate the TA-55 plutonium vault.

High Wind, TA-55 Waste Storage Area—The postulated wind-driven missile will not penetrate the pipe component.

Large Aircraft Crash—Since the annual frequency for this accident is in the not reasonably foreseeable range, the accident consequences were not evaluated.

Small (General Aviation) Aircraft Crash, Vault Storage—The TA-55 plutonium vault construction is very robust. The aircraft will not penetrate the TA-55 plutonium vault.

Small (General Aviation) Aircraft Crash, TA-55 Waste Storage Area—The aircraft will not penetrate the pipe component.

Vault Fire—No storage containers would be breached by the fire.

TA-55 Waste Storage Area Fire—No storage containers would be breached by the fire.

Earthquake and TA-55 Plutonium Vault Collapse—The scenario postulated that the earthquake collapsed the vault. The analysis conservatively postulated that 1% of the 3013 containers were breached by the falling building debris. The accident source term is presented in **Table D–72**.

Table D–72 Earthquake and TA-55 Plutonium Vault Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
ER & MSE Salt	792	0.01	0.000792	0.1	0.627	Ground
DOR Salt	188	0.01	0.000792	0.1	0.149	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor TA = technical area DOR = direct oxide reduction salt
ER & MSE = electrorefining and molten salt extraction salt
[a] A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.

Earthquake and TA-55 Waste Storage Area Collapse—The scenario postulated that the earthquake collapsed the facility. The analysis conservatively postulated that 1% of the drummed pipe components were breached by the falling building debris. The accident source term is presented in **Table D–73**.

Table D–73 Earthquake and TA-55 Waste Storage Area Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
ER & MSE Salt	12.3	0.01	0.000792	0.1	0.00974	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor TA = technical area DOR = direct oxide reduction salt
ER & MSE = electrorefining and molten salt extraction salt
[a] A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.

Accident Frequency—The TA-55 Final Safety Analysis Report (LANL 1996) analyzed the impact of the evaluation basis earthquake (EBE) and beyond evaluation basis earth quakes (BEBEs) on the facility. The analysis disclosed that a 0.5 g BEBE would not cause structural collapse of the plutonium vault or the waste storage area in the basement. The 0.5 g BEBE was the most significant BEBE analyzed in the report. For the purpose of this EIS, it was conservatively assumed that a 0.5 g BEBE would collapse the TA-55 plutonium vault and waste storage area located in the basement. The return frequency for a 0.5 g BEBE is estimated at 0.000019 per year. (LANL 1996)

D.3.3.4.4 Alternative 4 – Combination of Processing Technologies

Following processing of plutronium residues at Rocky Flats using Alternative 4 processing technologies, the residue is packaged in drums, drummed convience cans, or drummed pipe components prior to movement to an interim storage area or staging area for shipment to WIPP. For the purpose of this EIS, the analysis assumed that the packaged material will be stored in Butler Buildings similar to those described in Section D.3.3.4.1. **Table D-74** presents the storage configuration for each Alternative 4 processing technology.

Table D–74 Alternative 4 Storage

Material		*Process Technology*	*Quantity*		*Storage*	
			Pu (kg)	*Drums*	*Drummed Pipe Component*	*Storage Area (ft^2)*
Ash Residue	Incinerator Ash	Calcination/Cementation	901	4,887	Yes	9,974
		Repackaging	901	5,304	Yes	10,608
	Sand, Slag, and Crucible	Calcination/Cementation	128	765	Yes	1,530
		Repackaging	128	773	Yes	1,546
	Graphite Fines	Calcination/Cementation	73	498	Yes	996
		Repackaging	73	431	Yes	862
	Inorganic Ash	Calcination/Cementation	51	273	Yes	546
		Repackaging	51	297	Yes	594
Pyrochemical Salt Residue	MSE Salt (IDC 409)	Repackaging	235	1,570	Yes	3,140
	MSE/ER Salt (all other IDCs)	Repackaging	569	3,800	Yes	7,600
	DOR Salt (IDCs 365, 413, 427)	Repackaging	138	834	Yes	1,668
	DOR Salt (all other IDCs)	Repackaging	51	306	Yes	612
Combustible Residue	Aqueous-Contaminated	Neutralization/Dry	9.4	405	No [a]	810
	Organic-Contaminated	Thermal Desorption/Steam Passivation	6.5	280	No [a]	560

Material		***Process Technology***	***Quantity***		***Storage***	
			Pu (kg)	***Drums***	***Drummed Pipe Component***	***Storage Area (ft^2)***
	Dry	Repackaging	5.4	231	No [a]	462

Material		Process Technology	Quantity		Storage	
			Pu (kg)	Drums	Drummed Pipe Component	Storage Area (ft^2)
Plutonium Fluoride Residue		None/ Not Applicable	0	0	-	0
Filter Media Residue	Full Flow Filters (IDC 331)	None/Not Applicable	0	0	-	0
	HEPA Filters (IDC 338)	Neutralization/Dry	91	3,920	No [a]	7,840
	HEPA Filters (all other IDCs)	Repackaging	2	87	No [a]	174
Sludge Residue	IDCs 089, 099, 332	Repackaging	0.94	6	Yes	12
	All other IDCs	Filter/Dry	25.4	1,095	No [b]	2,190
Glass Residue		Neutralization/Dry	0.06	7	Yes	14
Graphite Residue		Repackaging	96.4	575	Yes	1,150
Inorganic Residue		Repackaging	17.5	106	Yes	212
Scrub Alloy		None/ Not Applicable	0	0	-	0

[a] Drummed.
[b] Drummed convenience can.

❒ **Plutonium Residue Vulnerability to Storage Accidents—**The same spectrum of storage-related accidents described in Section D.3.3.4.1 were considered. **Table D–75** summarizes the vulnerability of the processed residues in storage to the applicable set of postulated accidents.

Table D–75 Alternative 4 Plutonium Residue Vulnerability During Storage

Material	Stored Material Vulnerable to Accident			
	High Wind	Small Aircraft Crash	Room Fire	Earthquake and Building Collapse
Ash Residue	No	No	No	No
Salt Residue	No	No	No	No
Combustible Residue	Yes[a]	Yes[a]	Yes	Yes [b]
HEPA Filter Media Residue	Yes [a]	Yes [a]	Yes	Yes [b]
Sludge Residue (IDCs 089, 099, 332)	No	No	No	No
Sludge Residue (all other IDCs)	Yes [a]	Yes [a]	Yes	Yes [b]
Glass Residue	No	No	No	No
Graphite Residue	No	No	No	No
Inorganic Residue	No	No	No	No

[a] The combustible, filter media, and sludge residues would not be vulnerable to the effects of the high wind and small aircraft accidents if all combustible, filter media, and sludge residue drums were placed in the Butler building storage array configuration such that they were shielded from above and on the outer perimeter of the storage array configuration by drums that contain residues in pipe components. The analysis in this EIS took no credit for strategic placement of combustible, filter media, and sludge residue drums in the Butler building storage array configuration.

[b] The combustible, filter media, and sludge residues would not be vulnerable to the effects of the earthquake and building collapse accident if all combustible, filter media, and sludge residue drums were placed in the Butler building storage array configuration such that they were shielded from above, shielded on the outer perimeter of the storage array configuration, and shielded from building columns located within the storage array by drums that contain residues in pipe components. The analysis in this EIS took no credit for strategic placement of combustible, filter media, and sludge residue drums in the Butler building storage array configuration.

❒ **Accident Scenarios and Source Terms—**The source terms associated with the high wind, small aircraft crash, and room fire accident scenarios for combustible, filter media, and sludge residue presented in Section D.3.3.4.1 for Alternative 1 are applicable for Alternative 4. The source term for the earthquake and building collapse accident scenario changes because sludge residue IDCs 089, 099, and 332, packaged in drummed pipe components, are not vulnerable to the accident scenario. The accident source term is presented in **Table D–76**.

Table D–76 Earthquake and Butler Building Collapse Accident Source Term

Residue	*Mar Pu (kg)*	*DR*	*ARF×RF* [a]	*LPF*	*Source Term Pu (g)*	*Release Point*
Combustibles	21.3	0.01×0.1	0.000193	1	0.00411	Ground
HEPA Filter Media	93	0.01×0.1	0.000193	1	0.0180	Ground
Sludge[b]	25.4	0.01×0.1	0.000232 [c]	1	0.00589	Ground

MAR = material at risk DR = damage ratio ARF = airborne release fraction RF = respirable release fraction
LPF = leak path factor

[a] The ARF×RF product for a spill is assumed equivalent to a dock spill. The ARF×RF product does not include the potential for resuspension of particulates after an earthquake. A resuspension value of 0.000192 needs to be added to all ARF×RF values. Reference Table D–29.

[b] IDCs 089, 099, and 332 are excluded.

[c] Dry powder, assumed same as ash.

❒ **Accident Frequency —**Accident frequencies were derived for the combustible, filter media and sludge residues using data presented in Table D–41. **Table D–77** presents the accident frequencies for Alternative 4 storage.

Table D–77 Alternative 4 Accident Frequency for Storage of Plutonium Residues

Material	*Accident Annual Frequency*			
	High Wind	*Small Aircraft Crash*	*Room Fire*	*Earthquake and Building Collapse*
Ash Residue	N/A	N/A	N/A	N/A
Salt Residue	N/A	N/A	N/A	N/A
Combustible Residue	0.000813	2.44×10^{-7}	0.00001	0.002
Filter Media Residue	0.00356	1.07×10^{-6}	0.00001	0.002
Sludge Residue	0.000972	2.91×10^{-7}	0.00001	0.002
Glass Residue	N/A	N/A	N/A	N/A
Graphite Residue	N/A	N/A	N/A	N/A
Inorganic Residue	N/A	N/A	N/A	N/A

N/A = not applicable

The storage period for Alternative 4 is not defined since these residues will be shipped to WIPP when resources at WIPP are available to accept the residues for storage and transportation resources are available. Since the storage period at Rocky Flats is not specifically defined for Alternative 4, annual accident risks are estimated.

D.3.3.5 Consequences and Risk Calculations

Once the source term for each accident scenario is determined, the radiological consequences are calculated. The calculations vary depending on how the release is dispersed, what material is involved, and which receptor is being considered. Risks are calculated based on the accident's frequency and its consequences. The composite risk from performing a specific processing technology can be calculated summing the individual risks for all scenarios analyzed.

Radiological consequences to four different receptors are evaluated: a maximally exposed offsite individual (an individual member of the public), general population, noninvolved worker (or a co-located worker), and facility worker. The consequences to the facility workers are qualitatively evaluated. For the other receptors, quantitative estimates of consequences are made; two types of dispersion conditions are considered—95th-percentile and 50th-percentile meteorological conditions (see Section D.3.1 for more detail). The 50th-percentile condition represents the median meteorological condition and is defined as that for which more severe conditions occur 50 percent of the time. The 95th-percentile condition represents relatively low probability meteorological conditions that produce higher calculated exposures; it is defined as that condition not exceeded more than 5 percent of the time. Both dispersion conditions are modeled using the GENII program, which determines the desired condition from the site-specific meteorological data in the form of a joint frequency distribution. Joint frequency data are usually produced from at least 3 consecutive years of site weather data in terms of percentage of time that the wind blows in specific directions (e.g., south, south-southwest, southwest) for the given midpoint (or average) wind speed class and atmospheric stability.

Radiological consequences to a receptor are estimated based on a calculated 50-year committed dose factor, (dose factor) resulting from releases of 1 g of respirable aged weapon-grade plutonium or high americium plutonium salts (building source term) to the atmosphere. **Table D–78** and **Table D–79** provide the dose factor, in rem or person-rem per 1 g of respirable plutonium release to the atmosphere, for each receptor at a management site for two material types (e.g., aged weapon-grade plutonium and high americium plutonium salts) in either a metal or an oxide form and for two dispersion conditions. The dose factors given for the plutonium metal form in each category represent clearance half-time (solubility class) of "W," and the dose factors given for the plutonium oxide form represent clearance half-time of "Y" (see Section D.3.3.1).

Table D–78 Receptors' Dose Factors for Accidental Releases of 1 g Aged Weapon-Grade Plutonium at Management Sites

Receptor	*Release Location*	*Rocky Flats Building 707*		*Rocky Flats Building 371*		*Savannah River Site Building 221-F*		*Savannah River Site Building 221-H*		*LANL TA-55*
		Oxide	*Metal*	*Oxide*	*Metal*	*Oxide*	*Metal*	*Oxide*	*Metal*	*Metal*
Dose factors (rem or person-rem) from a release of 1 g aged weapon-grade plutonium and 95th-percentile meteorological condition										
MEI	Ground	1.20	2.40	1.80	3.60	0.050	0.0920	0.037	0.069	6.2
MEI	Elevated	0.160	0.320	1.50	3.0	0.0190	0.0340	0.017	0.032	5.1
Population	Ground	25,000	42,000	25,000	42,000	2,000	3,300	1,900	3,100	7,800
Population	Elevated	8,700	15,000	25,000	42,000	1,000	1,800	1,000	1,600	7,800
Dose factors (rem or person-rem) from a release of 1 g aged weapon-grade plutonium and 50th-percentile meteorological condition										
MEI	Ground	0.13	0.26	0.18	0.36	0.00940	0.017	0.0074	0.0014	0.81
MEI	Elevated	0.06	0.12	0.17	0.34	0.00680	0.012	0.005	0.0096	0.76
Population	Ground	600	1,000	600	1,000	140	230	130	200	840
Population	Elevated	450	770	600	1,000	99	160	90	150	840
Worker	Ground	21	28	21	28	17	22	17	22	65
Worker	Elevated	0.14	0.19	1.80	2.50	0.076	0.10	0.076	0.10	4.50

LANL = Los Alamos National Laboratory TA = technical area MEI = maximally exposed individual
Metal = plutonium compounds having clearance class "W" Oxide = plutonium oxides having clearance class "Y"

Table D–79 Receptors' Dose Factors for Accidental Releases of 1 g High Americium Plutonium Salt at Management Sites

Receptor	*Release Location*	*Rocky Flats Building 707*		*Rocky Flats Building 371*		*Savannah River Site Building 221-F*		*Savannah River Site Building 221-H*		*LANL TA-55*
		Oxide	*Metal*	*Oxide*	*Metal*	*Oxide*	*Metal*	*Oxide*	*Metal*	*Oxide*
Dose factors (rem or person-rem) from a release of 1 g high americium plutonium salt and 95th-percentile meteorological condition										
MEI	Ground	14	16	22	24	0.56	0.60	0.42	0.45	38.0
MEI	Elevated	1.90	2.10	18	19	0.21	0.220	0.19	0.21	31.0
Population	Ground	2.60×10^5	2.80×10^5	2.60×10^5	2.80×10^5	20,000	21,000	19,000	20,000	50,000
Population	Elevated	90,000	96,000	2.60×10^5	2.70×10^5	11,000	12,000	10,000	11,000	36,000

Receptor	Release Location	Rocky Flats Building 707		Rocky Flats Building 371		Savannah River Site Building 221-F		Savannah River Site Building 221-H		LANL TA-55
		Oxide	Metal	Oxide	Metal	Oxide	Metal	Oxide	Metal	Oxide
Dose factors (rem or person-rem) from a release of 1 g high americium plutonium salt and 50th-percentile meteorological condition										
MEI	Ground	1.50	1.70	2.20	2.40	0.099	0.110	0.084	0.090	4.90
MEI	Elevated	0.72	0.79	2.10	2.20	0.077	0.082	0.059	0.063	4.60
Population	Ground	6,200	6,700	6,200	6,700	1,400	1,500	1,300	1,300	5,100
Population	Elevated	4,600	4,900	6,100	6,400	970	1,000	900	960	5,200
Worker	Ground	170	180	170	180	140	150	140	150	410
Worker	Elevated	1.20	1.20	16	16	0.63	0.66	0.63	0.66	2.80

LANL = Los Alamos National Laboratory TA = technical area MEI = maximally exposed individual
Metal = plutonium compounds having clearance class "W" Oxide = plutonium oxides having clearance class "Y"

The values given in these tables represent the maximum dose to the receptor and are obtained using the GENII program, as described in Sections D.3.1.1 and D.1.2.1 of this appendix. The compositions of the aged weapon-grade plutonium and the high americium plutonium salts are given in **Table D–80**. The selections of the aged weapon-grade plutonium and the high americium salts were made to bound the consequences of the accidents involving different plutonium residue materials. As weapon-grade plutonium ages, the concentration of americium increases. The specific activity of americium is significantly higher than that of weapon-grade plutonium. The radiological hazard in terms of committed effective dose equivalent associated with the 1 g of americium is approximately 43 times greater than for 1 g of weapon-grade plutonium, adjusting for the differences between specific activities and the committed effective dose equivalent dose conversion factors of each isotope. The aged weapon-grade plutonium reflects the highest amount of americium 241 that can be present in any of the weapon-grade plutonium residues except the molten salt extraction residues. For the salt residues, the composition of Item Description Codes (IDCs) 409–410 was used. Although these IDCs represent approximately 24 percent of the total salts, they have the highest content of americium 241.

Table D–80 Compositions of Different Types of Plutonium Mixture at Rocky Flats

Isotope	Processed Weapon-Grade Plutonium [a]		Aged Weapon-Grade Plutonium		High Americium Salt [b]	
	g/g-mix	Ci/g-mix	g/g-mix	Ci/g-mix	g/g-mix	Ci/g-mix
Plutonium 238	0.000292	0.005	0.000165	0.0028	0.00009	0.00147
Plutonium 239	0.926	0.0576	0.924	0.057	0.809	0.0503
Plutonium 240	0.0566	0.0129	0.0561	0.013	0.05	0.0114
Plutonium 241	0.00325	0.335	0.000102	0.011	0.0031	0.32
Plutonium 242	0.000306	1.20×10^{-6}	0.000306	1.2×10^{-6}	0.000259	1.02×10^{-6}
Americium 241	0.000175	0.0006	0.00305	0.011	0.138	0.473
Total	0.99	0.411	0.985	0.095	1	0.856

g/g-mix = gram/gram-mixture Ci/g-mix = curies per gram-mixture
[a] Rocky Flats weapon-grade plutonium compositions.
[b] Compositions of IDC 409 and IDC 410 were used.

Source: BIO Radiological Dose Consequence Template (RF 1996).

For each accident scenario except criticality, the radiological consequences (rem or person-rem) to each receptor are estimated by multiplying the calculated building source term with the receptor's dose factor, given in Table D–78 and Table D–79. For example, the maximally exposed individual dose at the Savannah River Site for releases caused by an accidental plutonium oxide (ash) powder spill in the new special recovery facility, is calculated by *multiplying* the building source term resulting from the spill, which is estimated to be ~0.01 mg ([178]×[10^{-5}]×[0.005]) of plutonium from values given in Table D–30, *with* the dose factor of 0.019 rem/g plutonium from Table D–78 to get a maximally exposed individual dose of 1.9×10^{-7} rem, or 1.9×10^{-4} mrem, per spill.

The maximally exposed individual risk from this event is the accident frequency, which is 0.01 per year (given in the accident scenario description in Section D.3.3.2) multiplied by the consequence (dose factor), resulting in 1.9×10^{-6} mrem/yr. The risk is also stated in terms of additional latent cancer fatalities resulting from a release using a conversion factor of 5×10^{-4} latent cancer fatalities per person rem for the individual member of the public and 4×10^{-4} latent cancer fatalities per person-rem for a worker. For this example, the risk to the maximally exposed individual is calculated by multiplying 1.9×10^{-6} mrem/yr, 0.001 rem/mrem, and 5×10^{-4} latent cancer fatalities per rem, which results in 9.5×10^{-13} latent cancer fatalities per year.

For the criticality accidents, direct calculations of consequences are made based on the fission gas and plutonium releases resulting from a solution criticality event of 1×10^{19} fissions at the Savannah River Site and at Rocky Flats. At Los Alamos National Laboratory, direct calculations of consequences are made based on fission gas releases during a criticality excursion event of 10^{18} fissions in terms of rem and/or person-rem for the 50th- and 95th-percentile meteorological conditions. **Table D-81** provides various receptor's doses from criticality accidents.

Table D–81 Criticality Accident Consequences at the Management Sites (Consequences Are in Terms of Rem for the Individuals and Person-rem for the Population)

	Rocky Flats Building 371		*SRS Building 221-F*		*SRS Building 221-H*		*LANL Building TA-55* [a]	
Receptor	***95% Met***	***50% Met***	***95% Met***	***50% Met***	***95% Met***	***50% Met***	***95% Met***	***50% Met***
MEI	0.79	0.11	0.011	0.0044	0.009	0.003	0.137	0.022
Population	6980	252	310	32	290	29	98.8	15.7
Worker	N/A	0.321	N/A	0.038	N/A	0.038	N/A	0.045

SRS = Savannah River Site LANL = Los Alamos National Laboratory TA = technical area
Met = meteorological data MEI = maximally exposed individual N/A = not applicable
[a] At Los Alamos National Laboratory, the doses are calculated for 10^{18} fissions; at other sites, the doses are for 10^{19} fissions.

Table D–82 Receptors' Dose Factors for Accidental Releases of 1 g Plutonium from Accident Initiated in FB-Line or HB-Line

	Plutonium Oxide		*Plutonium Metal*		*High Americium Salts (Metal)*	
Receptor	***95% Met***	***50% Met***	***95% Met***	***50% Met***	***95% Met***	***50% Met***
Accident Initiated in FB-Line						
MEI (rem)	0.015	0.0054	0.031	0.011	0.032	0.011

Receptor	*Plutonium Oxide*		*Plutonium Metal*		*High Americium Salts (Metal)*	
	95% Met	*50% Met*	*95% Met*	*50% Met*	*95% Met*	*50% Met*
Population (person-rem)	900	82	1600	150	1600	150
Worker (rem)	N/A	0.066	N/A	0.093	N/A	0.096
Accident Initiated in HB-Line						
MEI (rem)	0.013	0.0041	0.029	0.0088	0.031	0.009
Population (person-em)	900	75	1420	141	1470	144
Worker (rem)	N/A	0.066	N/A	0.093	N/A	0.096

Met = meteorological condition MEI = maximally exposed individual N/A = not applicable

For the accidents in the FB-Line or HB-Line facility, the receptors' dose factors would be lower than those presented in Tables D–78 and D–79. This is because the plutonium solutions entering the FB-Line or HB-Line processes are essentially americium-free solutions. **Table D–82** provides various receptors' dose factors from an FB-Line or HB-Line accidental release during the processing of Rocky Flats aged weapon-grade plutonium or high americium salts in terms of rem and/or person-rem for the 50th and 95th percentile meteorological conditions. The dose factors given in Table D–82 are applicable only to the ion exchange explosion accident. The plutonium materials released are metal compounds (i.e., have the clearance half-time of "W").

The consequences to involved workers are qualitatively assessed. This approach is used for two reasons: first, no adequate method exists for calculating meaningful consequences at or near the location where the accident occurs. Second, safety assurance for facility workers is demonstrated by both the workers' training and by the establishment of an Occupational Safety and Health Administration process safety management system (29 CFR 1910.119), the evaluations required by such a system, and the products derived from such evaluations (e.g., procedures, programs, emergency plans).

The consequences to the involved worker are accident dependent and site-specific. In facilities where the involved worker activities include remote operations, the consequences of accidents would be lower than in facilities where the workers are near the process. The following paragraphs summarize the various potential consequences to the involved workers from the hypothesized accidents at different management sites. Additionally, a limited number of fatalities could occur in an indirect or secondary manner—for example, the involved worker could be killed by an earthquake or explosion (see also **Table D–83** and **Table D–84**).

Table D–83 Involved Worker Consequences from Various Hypothesized Accidents

Accident	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Explosion (acetylene)	Could potentially result in fatal injuries (nonradiological) to the nearby involved workers.	N/A	N/A
Explosion (Ion Exchange)	Could potentially result in fatal injuries (nonradiological) to the nearby involved workers.	Could potentially result in fatal injuries (nonradiological) to the nearby involved workers.	N/A
Explosion (Hydrogen)	N/A	No fatality is expected due to remote operation.	N/A
Criticality	Could potentially result in fatal dose to the nearby involved workers.	Could potentially result in fatal dose to the nearby involved workers.	Could potentially result in fatal dose to the nearby involved workers.

Accident	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*
Fire	No fatality is expected, some nearby workers could inhale the dispersed radioactive materials before using respirator and leaving the area.	No fatality is expected, some nearby workers could inhale the dispersed radioactive materials before using respirator and leaving the area.	No fatality is expected, some nearby workers could inhale the dispersed radioactive materials before using respirator and leaving the area.
Earthquake	Some fatalities (nonradiological) are expected in Building 707.	No fatality is expected.	No fatality is expected.
Spill	Nearby workers could inhale the dispersed radioactive materials before using respirator and leaving the area.	Nearby workers could inhale the dispersed radioactive materials before using respirator and leaving the area.	Nearby workers could inhale the dispersed radioactive materials before using respirator and leaving the area.

N/A = not applicable

Table D–84 Involved Worker Summary

Accident Description	*Number of Involved Workers*	
Rocky Flats	**Building 707**	**Building 371**
Explosion, Acetylene	30	30
Explosion, Ion Exchange Column	N/A	30
Room Fire	30	30
Dock Fire	12	12
Room Spill	30	30
Glovebox Spill	0	0
Dock Spill	12	12
Earthquake	100	100
Savannah River Site—Purex Process (All Ash Residues)	**H-Canyon & HB-Line**	**F-Canyon & FB-Line**
Explosion, Hydrogen	16	21
Explosion, Ion Exchange Column	27	16
Nuclear Criticality	27	16
Fire	27	16
Earthquake	43	37
Savannah River Site—Purex Process (Not Ash Residue)	**H-Canyon & H-B Line**	**F-Canyon & F-B Line**
Explosion, Hydrogen	27	31
Explosion, Ion Exchange Column	27	16
Nuclear Criticality	27	16
Fire	27	16
Earthquake	54	47
Savannah River Site—Mediated Electrochemical Oxidation Process	**H-Canyon & HB-Line**	**F-Canyon & FB-Line**
Explosion, Hydrogen	16	23
Explosion, Ion Exchange Column	27	16
Nuclear Criticality	27	16
Fire	27	16
Spill	16	23
Earthquake	43	39
Los Alamos National Laboratory		
Nuclear Criticality	30	
Fire	30	

Accident Description	*Number of Involved Workers*
Spill	30
Earthquake	30

N/A = not applicable

- **Explosion—**The explosion could result in serious, even fatal, injuries to involved workers from the accident itself. Some of the involved workers could inhale the dispersed radioactive material before using their respirators and evacuating the area. No fatality is expected from the radiological consequences.

- **Fire—**Involved workers could inhale some radioactive material before using their respirators and immediately evacuating the building. No fatality is expected from the radiological consequences.

- **Spill—**Depending on the location of the spill, nearby workers may inhale the airborne radioactive materials before evacuating the area. Involved workers normally would be wearing respirators when handling the radioactive material containers. No fatality is expected to result from such an accident.

- **Earthquake—**Involved workers could receive lethal injuries from the accident itself. No fatality is expected from radiological consequences.

- **Aircraft Crash—**Consequences similar to those of an earthquake may result from the accident.

- **Criticality—**Involved workers could receive substantial, or potentially fatal, doses from prompt neutrons and gamma rays emitted from the first pulse. After the initial pulse, the workers would evacuate the area immediately on the initiation of the criticality monitoring alarms.

D.3.3.6 Analysis Conservatism and Uncertainty

To assist in evaluating the impact of the plutonium residue and scrub alloy processing options at Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory on a common basis, a spectrum of generic accidents were postulated for each process location. The accident scenarios were based on similar accidents documented in various site documents. When required, accident assumptions were modified to enable comparison between the three sites. In cases where similar accidents were evaluated in site specific documents, the more conservative analysis assumptions were used for all sites to normalize the results for the purpose of comparison. The following accident analysis parameters have a major impact on accident consequence estimates (i.e., dose to the public and worker): the weather conditions existing at the time of the accident, the material at risk, the isotopic breakdown of the material at risk, and the source term released to the environment.

Weather conditions assumed at the time of the accident have a large impact on dose estimates. Accident impacts to the public were estimated using both 95 percentile and median 50 percentile weather data. The public impacts documented in the body of the EIS are based on the conservative 95 percentile weather data. The GENII computer code was used to calculate doses to the public within 80 km (50 miles) of the accident release point. The code calculates the public dose in each of 16 sectors centered at the accident release point. The GENII computer code also assumes that total source term is released into each sector and that there is no change in the weather (i.e., wind direction, wind speed, and stability class) while the accident plume is traversing the 80 km sector. The use of the conservative 95 percentile weather data rather than the expected or median 50 percentile weather data increases the dose to the public by more than a factor of 40.

Conservative assumptions were used to estimate the material at risk. If an accident scenario involved the contents of a room or a facility, the analysis assumed that the material at risk was equivalent to the amount of material that could be processed in one week. If an accident scenario involved one or more containers of material, the analysis assumed that the first container contained the maximum amount of material and any additional containers contained the average amount of material. Only a small percentage of containers contain the maximum amount.

The isotopic breakdown of the material at risk was also conservatively estimated. The composition of the Item Code Descriptions (IDCs) for each group of materials were reviewed and the IDCs with the most unfavorable isotopic breakdown, from a dose point-of-view, were selected as being representative for the group.

Uncertainties in accident frequencies do not impact the accident consequences, but do impact accident risk. The site/facility specific accident frequencies (i.e., earthquake induced building collapse and aircraft crash) were based on data provided by the sites. Process specific accident frequencies were estimated based on analyses provided in site specific documentation. In cases where similar accidents were evaluated in site specific documents, the more conservative accident frequency was used for all sites to normalize the results for the purpose of comparison.

Due to the layers of conservatism built into the accident analysis for the spectrum of postulated accidents, the estimated consequences and risk to the public represents the upper limit for the individual classes of accidents. The uncertainties associated with the accident frequency estimates and process batch sizes documented in the process data sheets are enveloped by the analysis conservatism.

D.3.3.7 Comparison of Analysis Results with Site Documents

The accident analysis consequences and risks should not be expected to be in agreement with accident analyses presented in site documentation (e.g., safety analysis reports, cumulative impact documents). To assist in evaluating the impact of the plutonium residue and scrub alloy processing options at Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory on a common basis, a spectrum of generic accidents were postulated for each process location. The accident scenarios were based on similar accidents documented in various site documents. When required, accident assumptions were modified to enable comparison between the three sites.

The material at risk for each accident was estimated based on the process data sheets. For the purpose of comparison, a common set of ground rules was used to estimate the source term released to the environment during the accidents. A common computer code and site specific weather data were used to assess the impact of each accident. Public impacts were estimated using both 95 percentile and 50 percentile weather data. The public impacts documented in the body of the EIS are based on the conservative 95 percentile weather data. The impacts to the non involved worker, nominally located 100 meters from the accident radiological release point, are based on the median 50 percentile weather data.

In the event that accident analysis consequences and risks in this EIS are compared with accident analyses presented in site documentation (e.g., safety analysis reports, cumulative impacts documents, etc.), do not expect the analysis results to be the same. The differences in the results may be attributed to differences in one or more of the following:

- Computer codes used for analysis
- Analysis data bases (e.g., population, weather, agriculture)
- Accident scenario

- Analysis ground rules and assumptions
- Material at risk
- Source term released to the environment
- Source term isotopic breakdown
- Accident frequency
- Process duration.

For example, a comparison was made of a similar accident documented in the Rocky Flats Cumulative Impacts Document for the 1996 Baseline with this EIS. Both analyses evaluated an earthquake-induced collapse of Building 707. The cumulative impacts document estimated 0.52 latent cancer fatalities and this EIS estimated 147 latent cancer fatalities. Several factors are responsible for the differences between the two documents. They are provided below in approximate order of importance or impact.

- The cumulative impacts document uses the median value for weather and the EIS uses the conservative 95 percentile weather. For the earthquake accident scenario in this EIS, the 95 percentile weather yields a calculated value of 293,000 person-rem (147 latent cancer fatalities) for the population and the 50 percentile weather yields a calculated value of 7,000 person-rem (3.5 latent cancer fatalities) for the population).

- The cumulative impacts document uses the MACCS computer code and the EIS uses the GENII computer code. There are major differences in the calculational approaches used in the codes. The MACCS code calculates the dose based on sectors being sampled from the weather database, and the GENII code calculates the dose to each of 16 sectors for the specified sector weather condition. The sector with the largest dose is reported.

- The material at risk and isotopic breakdown of the material was estimated differently in the cumulative impacts document and the EIS. The cumulative impacts document used the actual material known to be in the building and calculated the amount of dispersible material based on conversion of plutonium metal to oxides, amount of oxides present, amount of residues present (with associated americium amounts) and amount of transuranic and low level waste present. The EIS used a simpler approach, in that it used two plutonium residue IDCs, 409 and 410, both molten salt extraction salts containing the maximum quantity of americium, as the worst case scenario, and assumed a 5-day supply of the residue to be present in Building 707 upon collapse from the earthquake. The high content of americium in the plutonium residue significantly increases the radiological dose from that residue.

D.3.4 Accident Analyses Consequences and Risks Results

This section summarizes the consequences and risks to individuals and the general public from the operation of different residue processes (technologies) considered in this EIS. For each residue process, there are four alternatives: No Action, Processing without Plutonium Separation, Processing with Plutonium Separation, and Combination of Processing Technologies. The following subsections provide the summary results for each residue category and processing technology that were considered in this EIS. The details of each processing technology are provided in Appendix C and are summarized in Chapter 2 of this EIS; they will not be repeated here. The process data for each technology are provided by the DOE management sites. For example, the Rocky Flats Field Office provided the process data sheets for those technologies that will be performed at Rocky Flats; the Westinghouse Savannah River Company provided process data sheets for the technologies that will be performed at the Savannah River Site; and Los Alamos National Laboratory provided the process data sheets for the technologies that will be performed at Los Alamos National Laboratory (SAIC 1998a).

The results provided on the following pages represent the incremental increase in risks associated with the implementation of each processing technology. In evaluating the risk for the processing technologies, this EIS used the following assumptions and simplifications:

For each processing technology, the material at risk is the residue material in its most vulnerable form.

For the room fire and the earthquake accident scenarios, the material at risk is a 5-day supply, or a weekly throughput. The supply is divided into 3 days of feed and 2 days of product.

For earthquakes, risk is calculated only for a frequency that results in the total collapse or breach of the building.

When there is no building damage, the Building 371 earthquake-initiated fire and explosion are limited to the affected rooms. The Building 371 Basis for Interim Operation report identified the analytical laboratory (Room 3412) as the source of the explosion and the Caustic Waste Treatment System area (Rooms 1103, 1105, 1113, and 1115) as the main source of the fire. Although the earthquake-initiated fire and explosion were important for the Basis for Interim Operation report, they will not be considered in this EIS because the location of the gloveboxes for proposed processing technologies (Room 3701) is separated from the affected rooms. The explosion would be localized and would not damage the building. The whole building must be involved for the fire to spread and involve Room 3701; and the probability of this happening is smaller than that of another fire scenario that will be evaluated in this EIS.

For earthquake-initiated criticality, the bound is the 1×10^{19} fission criticality event analyzed for the plutonium liquid processes.

When a process involves operations in more than one building, it will be treated as two independent subprocesses with an interim storage in between. For example, in the acid dissolution of residues, the process of changing the residue to a calcined plutonium starts in Building 371; the final calcination occurs in Building 707A after a temporary storage in that building vault. Two sets of accident scenarios, one in Building 371 and the second in Building 707A, will be applied to residue materials that use this processing technology.

D.3.4.1 Ash Residues

D.3.4.1.1 Alternative 1 – No Action

The ash residues processing technology considered for this alternative is calcination/cementation. All ash residue (incinerator ash, SS&C, graphite fines, and inorganic) can be processed using the calcination/ cementation technology. The calcination/cementation process will be performed at Rocky Flats in Building 371, Room 3701. Building 707 is under consideration as an alternate location for the process. The accident analysis evaluates both the primary and alternate locations.

Table D–85 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of calcination/cementation processing technology of ash at Rocky Flats. **Table D–86** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of ash residues. The risks associated with this processing technology are summarized in **Table D–87** and **Table D–88**.

Table D–85 Ash Residue Accident Scenario Parameters for the Calcination/Cementation Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Ash Residues*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	2/0 [b]	4,000 g
Nuclear Criticality [c]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [d]	2	3,507 g supply + 2,338 g product [e]
b. Loading Dock	2.0×10^{-6}	4 drums [f]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the limit [g]	2	600 g
b. Glovebox	0.8	1 feed prep container	2	83.5 g
c. Loading Dock	0.001	1 drum [h]	0	3,000 g
Earthquake				
a. Building 371	0.000094	5-day supply [d]	0	3,507 g supply + 2,338 g product [e]
b. Building 707	0.0026	5-day supply [d]	0	3,507 g supply + 2,338 g product [e]
Aircraft Crash				
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–
b. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion					
a. Building 371	1.0	0.001	0.1	2.0×10^{-6}	Elevated
b. Building 707	1.0	0.001	0.1	1.0	Ground
Nuclear Criticality [c]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Spill:					
a. Room	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.5	0.1	Ground
Earthquake	1.0	0.002 [j]	0.3 [j]	0.1	Ground
Aircraft Crash					
a. Building 371 [k]	–	–	–	–	–
b. Building 707 [l]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] Building 371, 2 HEPA Banks; Building 707, 0 HEPA Banks.

[c] The wet nuclear criticality is not a viable accident scenario for the calcination/cementation technology assessment.

[d] 3-day supply of feed and 2-day supply of product.

[e] The product is cemented ash. The effect of the cemented ash product on the accident source term is negligible.

[f] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[g] 5 containers per drum of feed.

[h] 1 drum at the maximum plutonium content level.

[j] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[k] The aircraft will not penetrate the building.

[l] Consequences enveloped by the earthquake.

Table D–86 Summary of the Ash Residue Accident Analysis Doses for the Calcination/Cementation Process at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371							
Explosion	8.00×10^{-7}	Oxide	1.20×10^{-6}	1.36×10^{-7}	0.02	0.00048	1.44×10^{-6}
Fire (Room)	0.021	Oxide	0.0379	0.00379	526	12.6	0.442
Fire (Dock)	0.0018	Oxide	0.00324	0.000324	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.80×10^{-8}	2.04×10^{-9}	0.0003	7.20×10^{-6}	2.16×10^{-8}
Spill (Glovebox)	1.67×10^{-9}	Oxide	2.51×10^{-9}	2.84×10^{-10}	0.0000418	1.00×10^{-6}	3.01×10^{-9}
Spill (Dock)	0.003	Oxide	0.0054	0.00054	75.0	1.80	0.063
Earthquake	0.278	Oxide	0.50	0.050	6,940	167	5.83
Building 707							
Explosion	0.400	Oxide	0.480	0.0520	10,000	240	8.40
Fire (Room)	0.021	Oxide	0.0253	0.00297	526	12.6	0.442
Fire (Dock)	0.00180	Oxide	0.00216	0.000234	45.0	1.08	0.378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.4×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Oxide	2.67×10^{-10}	1.00×10^{-10}	0.0000145	7.52×10^{-7}	2.34×10^{-10}
Spill (Dock)	0.00300	Oxide	0.00360	0.000390	75.0	1.80	0.0630
Earthquake	0.278	Oxide	0.331	0.0361	6,940	167	5.83

MEI = maximally exposed individual Met = meteorological data

Table D–87 Summary of the Ash Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Calcination/Cementation Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
Explosion	0.00005	3.00×10^{-14}	3.40×10^{-15}	5.00×10^{-10}	1.20×10^{-11}	2.88×10^{-14}
Fire (Room)	0.0005	9.47×10^{-9}	9.47×10^{-10}	0.000132	3.16×10^{-6}	8.84×10^{-8}
Fire (Dock)	2.0×10^{-6}	3.24×10^{-12}	3.24×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.20×10^{-14}	8.16×10^{-15}	1.20×10^{-9}	2.88×10^{-11}	6.91×10^{-14}
Spill (Glovebox)	0.8	1.00×10^{-12}	1.14×10^{-13}	1.67×10^{-8}	4.01×10^{-10}	9.62×10^{-13}
Spill (Dock)	0.001	2.70×10^{-9}	2.70×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.000094	2.35×10^{-8}	2.35×10^{-9}	0.000326	7.83×10^{-6}	2.19×10^{-7}
Building 707						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.000250	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	6.31×10^{-9}	6.48×10^{-10}	0.000132	3.16×10^{-6}	8.84×10^{-8}
Fire (Dock)	2.0×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	1.07×10^{-13}	4.01×10^{-14}	5.81×10^{-9}	3.01×10^{-10}	7.48×10^{-14}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	4.33×10^{-7}	4.69×10^{-8}	0.00903	0.000217	6.07×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–88 Alternative 1 Accident Risks During Ash Residue Processing

Ash Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Calcination/Cementation Process- Building 371						
Incinerator Ash	3.00	1.07×10^{-7}	1.07×10^{-8}	0.00149	0.0000357	9.99×10^{-7}
SS&C	0.42	1.50×10^{-8}	1.50×10^{-9}	0.000208	4.99×10^{-6}	1.40×10^{-7}
Graphite Fines	0.24	8.56×10^{-9}	8.56×10^{-10}	0.000119	2.85×10^{-6}	7.99×10^{-8}
Inorganic Ash	0.17	6.06×10^{-9}	6.06×10^{-10}	0.0000842	2.02×10^{-6}	5.66×10^{-8}
All Ash Residues	3.83	1.37×10^{-7}	1.37×10^{-8}	0.00190	0.0000455	1.28×10^{-6}
Calcination/Cementation Process - Building 707						
Incinerator Ash	3.00	1.36×10^{-6}	1.47×10^{-7}	0.0283	0.000680	0.0000190
SS&C	0.42	1.90×10^{-7}	2.06×10^{-8}	0.00397	0.0000952	2.67×10^{-6}

Ash Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Graphite Fines	0.24	1.09×10^{-7}	1.18×10^{-8}	0.00227	0.0000544	1.52×10^{-6}
Inorganic Ash	0.17	7.71×10^{-8}	8.35×10^{-9}	0.00161	0.0000385	1.08×10^{-6}
All Ash Residues	3.83	1.64×10^{-6}	1.88×10^{-7}	0.0362	0.000868	0.0000243

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality SS&C = sand, slag, and crucible ash residue

[a] Sum of postulated accident scenario risks

D.3.4.1.2 Alternative 2 – Processing without Plutonium Separation

The ash residue processing technologies considered for this alternative are calcination/vitrification, blend down, and cold ceramification. All ash residue (incinerator ash; sand, slag, and crucible; graphite fines; and inorganic) can be processed using the either the calcination/vitrification or the blend down technologies. The cold ceramification technology can process incinerator, graphite fines and inorganic ash residue. The calcination/vitrification process will be performed at Rocky Flats in Building 707, Modules D and E; final drum packaging will be performed in Module F. The blend down process will be performed at Rocky Flats in Building 707, Module E. Building 371 is under consideration as an alternate location for the blend down process. The cold ceramification process will be performed at Rocky Flats in Building 707, Rooms 115, 120, 125, 126, 181, and 182. The accident analysis evaluates both the primary and alternate locations for the blend down process. Similar accidents are applicable to both of these technologies. **Table D–89** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of ash processing technology at Rocky Flats. **Table D–90** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of ash residues. The risks associated with these processing technologies are summarized in **Table D–91** and **Table D–92**.

Table D–89 Ash Residue Accident Scenario Parameters for the Vitrification, Blend Down, and Cold Ceramification Processes at Rocky Flats

Accident Scenario	Frequency (per year)	Ash Residues	HEPA Banks	Material at Risk (grams)			
				Calcination/ Vitrification Process [a]	Blend Down Process [b]		Cold Ceramification Process [p]
					Incinerator and Graphite Fines Ash Residue	SS&C and Inorganic Ash Residue	
Explosion	0.000050	2 drums [c]	0/2 [d]	4,000 g	4,000 g	4,000 g	4,000 g
Nuclear Criticality [e]	–	–	–	–	–	–	–
Fire:							
a. Room	0.0005	5-day supply [f]	2	4,810 g feed+3,206 g product [g]	7,014 g	1,520 g	8,000 g feed+ 5,344 g product [q]
b. Loading Dock	2.0×10^{-6}	4 drums [h]	0	6,000 g	6,000 g	6,000 g	6,000 g

Accident Scenario	*Frequency (per year)*	*Ash Residues*	*HEPA Banks*	*Material at Risk (grams)*			
					Blend Down Process [b]		
				Calcination/ Vitrification Process [a]	*Incinerator and Graphite Fines Ash Residue*	*SS&C and Inorganic Ash Residue*	*Cold Ceramification Process* [p]
Spill:							
a. Room	0.008	1 container at the limit [j]	2	600 g	600 g	600 g	600 g
b. Glovebox	0.8	1 feed prep container		83.5 g	83.5 g	18.1 g	167 g
c. Loading Dock	0.001	1 drum [k]	0	3,000 g	3,000 g	3,000 g	3,000 g
Earthquake:							
a. Building 707	0.0026	5-day supply [f]	0	4,810 g feed+3,206 g product [g]	7,104 g	1,520 g	8,016 g feed+5,344 g product [q]
b. Building 371	0.000094	5-day supply [f]	0	N/A	7,014 g	1,520 g	–
Aircraft Crash:							
a. Building 707	0.000030	Consequences enveloped by the earthquake.	–	–	–	–	–
b. Building 371	0.00004	The aircraft will not penetrate the building walls.	–	–	–	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.1	1.0	Ground
b. Building 371	1.0	0.001	0.1	2.0×10^{-6}	Elevated
Nuclear Criticality [e]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.5	0.1	Ground
Earthquake	1.0	0.002 [l]	0.3 [l]	0.1	Ground
Aircraft Crash:					
a. Building 707 [m]	–	–	–	–	–
b. Building 371 [n]	–	–	–	–	–

SS&C = sand, slag, and crucible

[a] Building 707, Modules D, E, and F.

[b] Building 707, Module E or Building 371 (alternate location).

[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level for plutonium content (1,000 g).

[d] Building 371, 2 HEPA Banks; Building 707, 0 HEPA Banks.

[e] The wet nuclear criticality is not a viable accident scenario for the calcination/vitrification and blend down technology assessments.

[f] 3-day supply of feed and 2-day supply of product.

[g] The product is glass. The effect of the vitrified product on the accident source term is negligible.
[h] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[j] 5 containers per drum of feed.
[k] 1 drum at the maximum plutonium content level.
[l] Add 0.000192 to all (ARF×RF) values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[m] Enveloped by the earthquake.
[n] The aircraft will not penetrate the building walls.
[p] Building 707, Rooms 115, 120, 125, 126, 181, and 182.
[q] The product is ceramic. The effect of the ceramic product on the accident source term is negligible.

Table D–90 Summary of the Ash Residue Accident Analysis Doses for the Vitrification and Blend Down Processes at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process							
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.40
Fire (Room)	0.0289	Oxide	0.0346	0.00375	722	17.3	0.606
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Oxide	2.67×10^{-10}	1.00×10^{-10}	0.0000145	7.52×10^{-7}	2.34×10^{-10}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.80	0.063
Earthquake	0.381	Oxide	0.457	0.0495	9,520	229	8.00
Blend Down Process (Incinerator and Graphite Fines Ash Residue)—Building 707							
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.40
Fire (Room)	0.0421	Oxide	0.0505	0.00547	1,050	25.3	0.884
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Oxide	2.67×10^{-10}	1.00×10^{-10}	0.0000145	7.52×10^{-7}	2.34×10^{-10}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.80	0.063
Earthquake	0.556	Oxide	0.667	0.0722	13,900	333	11.7
Blend Down Process (SS&C and Inorganic Ash Residue)—Building 707							
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.40
Fire (Room)	0.00912	Oxide	0.0109	0.00119	228	5.47	0.192
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	3.62×10^{-10}	Oxide	5.79×10^{-11}	2.17×10^{-11}	3.15×10^{-6}	1.63×10^{-7}	5.07×10^{-11}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.8	0.063
Earthquake	0.12	Oxide	0.144	0.0156	3,010	72.2	2.53
Blend Down Process (Incinerator and Graphite Fines Ash Residue)—Building 371							
Explosion	8.00×10^{-7}	Oxide	1.20×10^{-6}	1.36×10^{-7}	0.0200	0.000480	1.44×10^{-6}
Fire (Room)	0.0421	Oxide	0.0758	0.00758	1,050	25.3	0.884

	Building Source Term		***MEI (rem)***		***Population (person-rem)***		***Worker (rem)***
Accident Scenario	***(grams)***	***Type***	***95% Met***	***50% Met***	***95% Met***	***50% Met***	***50% Met***
Fire (Dock)	0.00180	Oxide	0.00324	0.000324	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.80×10^{-8}	2.04×10^{-9}	0.000300	7.20×10^{-6}	2.16×10^{-8}
Spill (Glovebox)	1.67×10^{-9}	Oxide	2.51×10^{-9}	2.84×10^{-10}	0.0000418	1.00×10^{-6}	3.01×10^{-9}
Spill (Dock)	0.00300	Oxide	0.00540	0.000540	75.0	1.80	0.0630
Earthquake	0.556	Oxide	1.00	0.100	13,900	333	11.7

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Blend Down Process (SS&C and Inorganic Ash Residue)—Building 371							
Explosion	8×10^{-7}	Oxide	1.20×10^{-6}	1.36×10^{-7}	0.02	0.00048	1.44×10^{-6}
Fire (Room)	0.00912	Oxide	0.0164	0.00164	228	5.47	0.192
Fire (Dock)	0.0018	Oxide	0.00324	0.000324	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.80×10^{-8}	2.04×10^{-9}	0.0003	7.20×10^{-6}	2.16×10^{-8}
Spill (Glovebox)	3.62×10^{-10}	Oxide	5.43×10^{-10}	6.15×10^{-11}	9.05×10^{-6}	2.17×10^{-7}	6.52×10^{-10}
Spill (Dock)	0.003	Oxide	0.0054	0.00054	75.0	1.8	0.063
Earthquake	0.12	Oxide	0.217	0.0217	3,010	72.2	2.53
Cold Ceramification Process (No SS&C)							
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.4
Fire (Room)	0.0481	Oxide	0.0577	0.00625	1,200	28.9	1.01
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	3.34×10^{-9}	Oxide	5.34×10^{-10}	2.00×10^{-10}	0.0000291	1.50×10^{-6}	4.68×10^{-10}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.8	0.063
Earthquake	0.635	Oxide	0.762	0.0825	15,900	381	13.3

SS&C = sand, slag, and crucible MEI = maximally exposed individual Met = meteorological data

Table D–91 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Calcination/Vitrification Process						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	8.66×10^{-9}	9.38×10^{-10}	0.00018	4.33×10^{-6}	1.21×10^{-7}
Fire (Dock)	2.0×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	1.07×10^{-13}	4.01×10^{-14}	5.81×10^{-9}	3.01×10^{-10}	7.48×10^{-14}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	5.94×10^{-7}	6.44×10^{-8}	0.0124	0.000297	8.32×10^{-6}
Blend Down Process (Incinerator and Graphite Fines Ash Residue)—Building 707						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	1.26×10^{-8}	1.37×10^{-9}	0.000263	6.31×10^{-6}	1.77×10^{-7}
Fire (Dock)	2.0×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	1.07×10^{-13}	4.01×10^{-14}	5.81×10^{-9}	3.01×10^{-10}	7.48×10^{-14}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	8.67×10^{-7}	9.39×10^{-8}	0.0181	0.000433	0.0000121

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Blend Down Process (SS&C and Inorganic Ash Residue)—Building 707						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	2.74×10^{-9}	2.96×10^{-10}	0.000057	1.37×10^{-6}	3.83×10^{-8}
Fire (Dock)	2.0×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	2.32×10^{-14}	8.69×10^{-15}	1.26×10^{-9}	6.52×10^{-11}	1.62×10^{-14}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	1.88×10^{-7}	2.03×10^{-8}	0.00391	0.0000939	2.63×10^{-6}
Blend Down Process (Incinerator and Graphite Fines Ash Residue)—Building 371						
Explosion	0.00005	3.00×10^{-14}	3.40×10^{-15}	5.00×10^{-10}	1.20×10^{-11}	2.88×10^{-14}
Fire (Room)	0.0005	1.89×10^{-8}	1.89×10^{-9}	0.000263	6.31×10^{-6}	1.77×10^{-7}
Fire (Dock)	2.0×10^{-6}	3.24×10^{-12}	3.24×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.20×10^{-14}	8.16×10^{-15}	1.20×10^{-9}	2.88×10^{-11}	6.91×10^{-14}
Spill (Glovebox)	0.8	1.00×10^{-12}	1.14×10^{-13}	1.67×10^{-8}	4.01×10^{-10}	9.62×10^{-13}
Spill (Dock)	0.001	2.70×10^{-9}	2.70×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.000094	4.70×10^{-8}	4.70×10^{-9}	0.000653	0.0000157	4.39×10^{-7}
Blend Down Process (SS&C and Inorganic Fines Ash Residue)—Building 371						
Explosion	0.00005	3.00×10^{-14}	3.40×10^{-15}	5.00×10^{-10}	1.20×10^{-11}	2.88×10^{-14}
Fire (Room)	0.0005	4.10×10^{-9}	4.10×10^{-10}	0.000057	1.37×10^{-6}	3.83×10^{-8}
Fire (Dock)	2.0×10^{-6}	3.24×10^{-12}	3.24×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.20×10^{-14}	8.16×10^{-15}	1.20×10^{-9}	2.88×10^{-11}	6.91×10^{-14}
Spill (Glovebox)	0.8	2.17×10^{-13}	2.46×10^{-14}	3.62×10^{-9}	8.69×10^{-11}	2.09×10^{-13}
Spill (Dock)	0.001	2.70×10^{-9}	2.70×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.000094	1.02×10^{-8}	1.02×10^{-9}	0.000141	3.39×10^{-6}	9.51×10^{-8}
Cold Ceramification Process (No SS&C)						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	1.44×10^{-8}	1.56×10^{-9}	0.000301	7.21×10^{-6}	2.02×10^{-7}
Fire (Dock)	2.0×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	2.14×10^{-13}	8.02×10^{-14}	1.16×10^{-8}	6.01×10^{-10}	1.50×10^{-13}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	9.90×10^{-7}	1.07×10^{-7}	0.0206	0.000495	0.0000139

SS&C = sand, slag, and crucible MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–92 Alternative 2 Accident Risks During Ash Residue Processing

Ash Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Calcination/Vitrification Process						
Incinerator Ash	2.18	1.34×10^{-6}	1.46×10^{-7}	0.028	0.000672	0.0000188
SS&C	0.31	1.91×10^{-7}	2.07×10^{-8}	0.00398	0.0000956	2.68×10-6
Graphite Fines	0.18	1.11×10^{-7}	1.20×10^{-8}	0.00231	0.0000555	1.55×10^{-6}
Inorganic Ash	0.12	7.40×10^{-8}	8.02×10^{-9}	0.00154	0.000037	1.04×10^{-6}
All Ash Residues	2.79	1.72×10^{-6}	1.86×10^{-7}	0.0358	0.00086	0.0000241
Blend Down Process – Building 707						
Incinerator Ash	2.47	2.21×10^{-6}	2.39×10^{-7}	0.046	0.0011	0.0000309
SS&C	1.61	3.29×10^{-7}	3.56×10^{-8}	0.00685	0.000164	4.61×10^{-6}
Graphite Fines	0.2	1.79×10^{-7}	1.93×10^{-8}	0.00372	0.0000893	2.50×10^{-6}
Inorganic Ash	0.64	1.31×10^{-7}	1.42×10^{-8}	0.00272	0.0000654	1.83×10^{-6}
All Ash Residues	4.92	2.84×10^{-6}	3.08×10^{-7}	0.0593	0.00142	0.0000398
Blend Down Process – Building 371						
Incinerator Ash	2.47	1.70×10^{-7}	1.70×10^{-8}	0.00235	0.0000565	1.58×10^{-6}
SS&C	1.61	2.74×10^{-8}	2.74×10^{-9}	0.00038	9.12×10^{-6}	2.55×10^{-7}
Graphite Fines	0.2	1.37×10^{-8}	1.37×10^{-9}	0.000191	4.58×10^{-6}	1.28×10^{-7}
Inorganic Ash	0.64	1.09×10^{-8}	1.09×10^{-9}	0.000151	3.62×10^{-6}	1.01×10^{-7}
All Ash Residues	4.92	2.21×10^{-7}	2.21×10^{-8}	0.00308	0.0000738	2.07×10^{-6}
Cold Ceramification Process						
Incinerator Ash	1.31	1.33×10^{-6}	1.45×10^{-7}	0.0278	0.000667	0.0000187
Graphite Fines	0.11	1.12×10^{-7}	1.21×10^{-8}	0.00233	0.000056	1.57×10^{-6}
Inorganic Ash	0.07	7.13×10^{-8}	7.72×10^{-9}	0.00149	0.0000357	9.98×10^{-7}
All Ash Residues	1.49	1.51×10^{-6}	1.65×10^{-7}	0.0316	0.000759	0.0000213

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality SS&C = sand, slag, and crucible

[a] Sum of postulated accident scenario risks

D.3.4.1.3 Alternative 3 – Processing with Plutonium Separation

The ash residue processing technologies considered for this alternative are the Purex/plutonium metal (or oxide) recovery process and the mediated electrochemical oxidation process. Either incinerator ash or sand, slag, and crucible residues can be processed using the Purex/plutonium metal recovery technology. Incinerator ash and graphite fine residue can be processed using the mediated electrochemical oxidation technology. Both of these processes will be performed in the Savannah River Site F-Canyon or H-Canyon. The ash residues will be preprocessed and packaged at Rocky Flats in Building 707, Module E, before shipment to the Savannah River Site for processing.

Similar accidents are applicable to both ash residue processing technologies and their associated ash residue preprocessing and packaging requirements. **Table D–93** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of preprocessing and packaging the ash residue at Rocky Flats and processing the residue using the Purex/plutonium metal recovery process and mediated electrochemical oxidation process at the Savannah River Site. **Table D–94** summarizes the consequences to the maximally exposed individual, the public, and workers from the accidental releases associated with preprocessing and packaging the residues at Rocky Flats and processing the residues at the Savannah River Site. The risks associated with the preprocessing and packaging at Rocky Flats and the Purex/plutonium metal or oxide recovery process and mediated electrochemical oxidation process at the Savannah River Site are summarized in **Table D–95** and **Table D–96**. The processes at the Savannah River Site can be performed in either the F-Canyon and FB-Line or the H-Canyon and HB-Line. Data are presented in Table D–93, Table D–94, Table D–95, and Table D–96 for both options.

Table D–93 Ash Residue Accident Scenario Parameters for the Purex/ Plutonium Metal or Oxide Recovery and Mediated Electrochemical Oxidation Processes

Rocky Flats Preprocessing and Packaging of Ash Residues for Shipment to the Savannah River Site for Processing						
				Material at Risk (grams)		
				Purex/Plutonium Metal or Oxide Recovery Process		*MEO Process*
Accident Scenario	*Frequency (per year)*	*Ash Residues*	*HEPA Banks*	*Ash (No SS&C)*	*SS&C*	*Ash (No SS&C)*
Explosion	0.00005	2 drums [a]	0	4,000 g	4,000 g	4,000 g
Nuclear Criticality [b]	–	–	–	–	–	–
Fire:						
a. Room	0.0005	5-day supply [c]	2	12,288 g	8,083 g	17,088 g
b. Loading Dock	2.0×10^{-6}	4 drums [d]	0	6,000 g	6,000 g	6,000 g
Spill:						
a. Room	0.008	1 container at the maximum limit [e]	2	600 g	600 g	600 g
b. Glovebox	0.8	1 feed prep container	2	128 g	84.2 g	178 g
c. Loading Dock	0.001	1 drum [f]	0	3,000 g	3,000 g	3,000 g
Earthquake	0.0026	5-day supply [c]	0	12,288 g	8,083 g	17,088 g
Aircraft Crash [g]	0.00003	Consequences enveloped by the earthquake.	–	–	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.1	1.0	Ground
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.5	0.1	Ground
Earthquake	1.0	0.002 [h]	0.3 [h]	0.1	Ground
Aircraft Crash [g]	–	–	–	–	–

Ash Residue Processing at the Savannah River Site F-Canyon				
		Material at Risk (grams)		
		Purex/Plutonium Metal Recovery Process		***MEO Process***
Accident Scenario	***Frequency (per year)***	***Ash (No SS&C)***	***SS&C***	***Ash (No SS&C)***
Explosion:				
a. Hydrogen	0.000015	4,000 g	2,000 g	6,000 g
b. Ion Exchange Column	0.0001	120.5 mg [j]	60.25 mg [j]	180.75 mg [j]
Nuclear Criticality [k]	0.0001	1.0×10^{19} fissions	1.0×10^{19} fissions	1.0×10^{19} fissions
Fire	0.00061	4,000 g	2,000 g	6,000 g
Spill	0.01	–	–	178 g
Earthquake:	0.000125			
a. F-Canyon Liquid		12,000 g	6,000 g	18,000 g
b. FB-Line:				
Powder		1,334 g	500 g	1,500 g
Molten Metal		1,333 g	500 g	1,500 g
Liquid		1,333 g	500 g	1,500 g

Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion:				
a. Hydrogen	1.0	0.001	0.005	Elevated
b. Ion Exchange Column	1.0	1.0	1.0	Elevated
Nuclear Criticality [k]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill	1.0	0.00001	0.005	Elevated
Earthquake:				
a. F-Canyon Liquid	1.0	0.000047	0.1	Ground
b. FB-Line:				
Powder	1.0	0.002	0.1	Ground
Molten Metal	1.0	0.0022	0.1	Ground
Liquid	1.0	0.000047	0.1	Ground

Ash Residue Processing at the Savannah River Site H-Canyon				
		Material at Risk (grams)		
		Purex/Plutonium Oxide Recovery Process		***MEO Process***
Accident Scenario	***Frequency (per year)***	***Ash (No SS&C)***	***SS&C***	***Ash (No SS&C)***
Explosion:				
a. Hydrogen	0.000015	1,000 g	1,000 g	6,000 g
b. Ion Exchange Column	0.0001	241 mg [j, l]	241 mg [j, l]	241 mg [j]
Nuclear Criticality [k]	0.0001	1.0×10^{19} fissions	1.0×10^{19} fissions	1.0×10^{19} fissions
Fire	0.00061	3,000 g	3,000 g	6,000 g
Spill	0.01	–	–	178 g
Earthquake:	0.000182			
a. H-Canyon Liquid		54,000 g	54,000 g	18,000 g
b. HB-Line Powder		4,000 g [l]	4,000 g [l]	4,000 g
HB-Line Liquid		4,000 g [l]	4,000 g [l]	4,000 g

Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion:				
a. Hydrogen	1.0	0.001	0.005	Elevated
b. Ion Exchange Column	1.0	1.0	1.0	Elevated
Nuclear Criticality [k]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill	1.0	0.00001	0.005	Elevated

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Earthquake:				
a. H-Canyon Liquid	1.0	0.000047	0.1	Ground
b. HB-Line Powder	1.0	0.002	0.1	Ground
HB-Line Liquid	1.0	0.000047	0.1	Ground

MEO = mediated electrochemical oxidation SS&C = sand, slag, and crucible DR = damage ratio ARF = airborne release fraction RF = respirable fraction

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content. The analysis conservatively assumed the maximum content level and the administrative control level for drums containing ash.

[b] The wet nuclear criticality is not a viable accident scenario for the residue packaging process in Building 707.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content. The analysis conservatively assumed the maximum content level and the administrative control level for drums containing ash.

[e] 5 containers per drum of feed. The analysis conservatively assumed the maximum content level and the administrative control level for drums containing ash.

[f] 1 drum at the maximum plutonium content level. The analysis conservatively assumed the maximum content level for a drum containing ash.

[g] Consequences enveloped by the earthquake.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[j] Respirable source term value in milligrams of plutonium released up the stack.

[k] Refer to Table D–28 for criticality source term.

[l] Duty cycle = 12.5%.

Table D–94 Summary of the Ash Residue Accident Analysis Doses for the Purex/ Plutonium Metal or Oxide Recovery and Mediated Electrochemical Oxidation Processes

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Preprocessing and Packaging of Ash (No SS&C) Residue for Purex Process at the Savannah River Site							
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.40
Fire (Room)	0.0737	Oxide	0.0885	0.00958	1,840	44.2	1.55
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	10,400	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	2.56×10^{-9}	Oxide	4.10×10^{-10}	1.54×10^{-10}	0.0000223	1.15×10^{-6}	3.58×10^{-10}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.80	0.063
Earthquake	0.973	Oxide	1.17	0.127	24,300	584	20.4
Rocky Flats Preprocessing and Packaging of SS&C Residue for Purex Process at the Savannah River Site							
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.40
Fire (Room)	0.0485	Oxide	0.0582	0.0063	1,210	29.1	1.02
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	1.68×10^{-9}	Oxide	2.69×10^{-10}	1.01×10^{-10}	0.0000147	7.58×10^{-7}	2.36×10^{-10}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.80	0.063

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Earthquake	0.64	Oxide	0.768	0.0832	16,000	384	13.4
Rocky Flats Preprocessing and Packaging of Ash (No SS&C) Residue for MEO Process at the Savannah River Site							
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.40
Fire (Room)	0.103	Oxide	0.123	0.0133	2,560	61.5	2.15
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	3.56×10^{-9}	Oxide	5.70×10^{-10}	2.14×10^{-10}	0.000031	1.60×10^{-6}	4.98×10^{-10}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.80	0.063
Earthquake	1.35	Oxide	1.62	0.176	33,800	812	28.4
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon—Ash (No SS&C) Residue							
Explosion (Hydrogen)	0.02	Metal	0.00068	0.00024	36.0	3.20	0.002
Explosion (Ion Exchange Column)	0.121	Metal-FB	0.00374	0.00133	193	18.1	0.0112
Criticality (Liquid)	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.2	Metal	0.0068	0.0024	360	32.0	0.02
Earthquake	0.623	Metal	0.0573	0.0106	2,050	143	13.7
MEO Process at the Savannah River Site F-Canyon—Ash (No SS&C) Residue							
Explosion (Hydrogen)	0.03	Metal	0.00102	0.00036	54.0	4.80	0.003
Explosion (Ion Exchange Column)	0.181	Metal-FB	0.0056	0.00199	289	27.1	0.0168
Criticality	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.3	Metal	0.0102	0.0036	540	48.0	0.03
Spill	8.90×10^{-6}	Metal	3.03×10^{-7}	1.07×10^{-7}	0.016	0.00142	8.90×10^{-7}
Earthquake	0.722	Metal	0.0664	0.0123	2,380	166	15.9
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon—SS&C Residue							
Explosion (Hydrogen)	0.01	Metal	0.00034	0.00012	18.0	1.60	0.001
Explosion (Ion Exchange Column)	0.0603	Metal-FB	0.00187	0.000663	96.4	9.04	0.0056

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	***(grams)***	***Type***	***95% Met***	***50% Met***	***95% Met***	***50% Met***	***50% Met***
Criticality (Liquid)	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.1	Metal	0.0034	0.0012	180	16.0	0.01
Earthquake	0.241	Metal	0.0221	0.00409	794	55.3	5.29
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon—Ash (No SS&C) Residue							
Explosion (Hydrogen)	0.005	Metal	0.00016	0.000048	8.00	0.75	0.0005
Explosion (Ion Exchange Column)	0.241	Metal-HB	0.00699	0.00212	342	34.0	0.0224
Criticality	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.15	Metal	0.0048	0.00144	240	22.5	0.015
Earthquake	1.07	Metal	0.074	0.015	3,330	215	23.6
MEO Process at the Savannah River Site H-Canyon—Ash (No SS&C) Residue							
Explosion (Hydrogen)	0.03	Metal	0.00096	0.000288	48.0	4.50	0.003
Explosion (Ion Exchange Column)	0.241	Metal-HB	0.00699	0.00212	342	34.0	0.0224
Criticality	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.3	Metal	0.0096	0.00288	480	45.0	0.03
Spill	8.90×10^{-6}	Metal	2.85×10^{-7}	8.54×10^{-8}	0.0142	0.00134	8.90×10^{-7}
Earthquake	0.903	Metal	0.0623	0.0126	2,800	181	19.9
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon—SS&C Residue							
Explosion (Hydrogen)	0.005	Metal	0.00016	0.000048	8.00	0.75	0.0005
Explosion (Ion Exchange Column)	0.241	Metal-HB	0.00699	0.00212	342	34.0	0.0224
Criticality	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.15	Metal	0.0048	0.00144	240	22.5	0.015
Earthquake	1.07	Metal	0.074	0.015	3,330	215	23.6

MEI = maximally exposed individual Met = meteorological data SS&C = sand, slag, and crucible
MEO = mediated electrochemical oxidation
[a] 1.0×10^{19} fissions.

Table D–95 Summary of the Ash Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Purex/Plutonium Metal or Oxide Recovery and Mediated Electrochemical Oxidation Processes

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Preprocessing and Packaging of Ash (No SS&C) Residue for Purex Process at the Savannah River Site						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	2.21×10^{-8}	2.40×10^{-9}	0.000461	0.0000111	3.10×10^{-7}
Fire (Dock)	2.00×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	1.64×10^{-13}	6.14×10^{-14}	8.91×10^{-9}	4.61×10^{-10}	1.15×10^{-13}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	1.52×10^{-6}	1.64×10^{-7}	0.0316	0.000759	0.0000425
Rocky Flats Preprocessing and Packaging of SS&C Residue for Purex Process at the Savannah River Site						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	1.45×10^{-8}	1.58×10^{-9}	0.000303	7.27×10^{-6}	2.04×10^{-7}
Fire (Dock)	2.00×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	1.08×10^{-13}	4.04×10^{-14}	5.86×10^{-9}	3.03×10^{-10}	7.54×10^{-14}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	9.99×10^{-7}	1.08×10^{-7}	0.0208	0.000499	0.000014
Rocky Flats Preprocessing and Packaging of Ash (No SS&C) Residue for MEO Process at the Savannah River Site						
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	3.08×10^{-8}	3.33×10^{-9}	0.000641	0.0000154	4.31×10^{-7}
Fire (Dock)	2.00×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	2.16×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	2.28×10^{-13}	8.54×10^{-14}	1.24×10^{-8}	6.41×10^{-10}	1.59×10^{-13}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	2.11×10^{-6}	2.29×10^{-7}	0.044	0.00106	0.0000591
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon—Ash (No SS&C) Residue						
Explosion (Hydrogen)	0.000015	5.10×10^{-12}	1.80×10^{-12}	2.70×10^{-7}	2.40×10^{-8}	1.20×10^{-11}
Explosion (Ion Exchange Column)	0.0001	1.87×10^{-10}	6.63×10^{-11}	9.64×10^{-6}	9.04×10^{-7}	4.48×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.0000155	1.60×10^{-6}	1.52×10^{-9}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Fire	0.00061	2.07×10^{-9}	7.32×10^{-10}	0.00011	9.76×10^{-6}	4.88×10^{-9}
Earthquake	0.000125	3.58×10^{-9}	6.62×10^{-10}	0.000128	8.95×10^{-6}	6.85×10^{-7}
MEO Process at the Savannah River Site F-Canyon—Ash (No SS&C) Residue						
Explosion (Hydrogen)	0.000015	7.65×10^{-12}	2.70×10^{-12}	4.05×10^{-7}	3.60×10^{-8}	1.80×10^{-11}
Explosion (Ion Exchange Column)	0.0001	2.80×10^{-10}	9.94×10^{-11}	0.0000145	1.36×10^{-6}	6.72×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.0000155	1.60×10^{-6}	1.52×10^{-9}
Fire	0.00061	3.11×10^{-9}	1.10×10^{-9}	0.000165	0.0000146	7.32×10^{-9}
Spill	0.01	1.51×10^{-12}	5.34×10^{-13}	8.01×10^{-8}	7.12×10^{-9}	3.56×10^{-12}
Earthquake	0.000125	4.15×10^{-9}	7.67×10^{-10}	0.000149	0.0000104	7.94×10^{-7}
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon—SS&C Residue						
Explosion (Hydrogen)	0.000015	2.55×10^{-12}	9.00×10^{-13}	1.35×10^{-7}	1.20×10^{-8}	6.00×10^{-12}
Explosion (Ion Exchange Column)	0.0001	9.34×10^{-11}	3.31×10^{-11}	4.82×10^{-6}	4.52×10^{-7}	2.24×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.0000155	1.60×10^{-6}	1.52×10^{-9}
Fire	0.00061	1.04×10^{-9}	3.66×10^{-10}	0.0000549	4.88×10^{-6}	2.44×10^{-9}
Earthquake	0.000125	1.38×10^{-9}	2.56×10^{-10}	0.0000496	3.46×10^{-6}	2.65×10^{-7}
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon—Ash (No SS&C) Residue						
Explosion (Hydrogen)	0.000015	1.20×10^{-12}	3.60×10^{-13}	6.00×10^{-8}	5.63×10^{-9}	3.00×10^{-12}
Explosion (Ion Exchange Column)	0.0001	4.37×10^{-11}	1.33×10^{-11}	2.14×10^{-6}	2.12×10^{-7}	1.12×10^{-10}
Criticality	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	1.46×10^{-9}	4.39×10^{-10}	0.0000732	6.86×10^{-6}	3.66×10^{-9}
Earthquake	0.000182	2.24×10^{-9}	4.54×10^{-10}	0.0001	6.48×10^{-6}	1.14×10^{-6}
MEO Process at the Savannah River Site H-Canyon—Ash (No SS&C) Residue						
Explosion (Hydrogen)	0.000015	7.20×10^{-12}	2.16×10^{-12}	3.60×10^{-7}	3.38×10^{-8}	1.80×10^{-11}
Explosion (Ion Exchange)	0.0001	3.49×10^{-10}	1.06×10^{-10}	0.0000171	1.70×10^{-6}	8.97×10^{-10}
Criticality	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.93×10^{-9}	8.78×10^{-10}	0.000146	0.0000137	7.32×10^{-9}
Spill	0.01	1.42×10^{-12}	4.27×10^{-13}	7.12×10^{-8}	6.68×10^{-9}	3.56×10^{-12}
Earthquake	0.000182	5.67×10^{-9}	1.15×10^{-10}	0.000255	0.0000164	1.45×10^{-6}

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon—SS&C Residue						
Explosion (Hydrogen)	0.000015	1.20×10^{-12}	3.60×10^{-13}	6.00×10^{-8}	5.63×10^{-9}	3.00×10^{-12}
Explosion (Ion Exchange Column)	0.0001	4.37×10^{-11}	1.33×10^{-11}	2.14×10^{-6}	2.12×10^{-7}	1.12×10^{-10}
Criticality	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	1.46×10^{-9}	4.39×10^{-10}	0.0000732	6.86×10^{-6}	3.66×10^{-9}
Earthquake	0.000182	2.24×10^{-9}	4.54×10^{-10}	0.0001	6.48×10^{-6}	1.14×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data SS&C = sand, slag, and crucible
MEO = mediated electrochemical oxidation

Table D–96 Alternative 3 Accident Risks During Ash Residue Processing

Ash Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Rocky Flats Preprocessing and Packaging of Ash (No SS&C) for Purex Process at the Savannah River Site						
Incinerator Ash	1.41	2.19×10^{-6}	2.37×10^{-7}	0.0457	0.0011	0.0000606
Rocky Flats Preprocessing and Packaging of SS&C Residue for Purex Process at the Savannah River Site						
SS&C	0.31	3.18×10^{-7}	3.45×10^{-8}	0.00663	0.000159	4.46×10^{-6}
Rocky Flats Preprocessing and Packaging of Ash (No SS&C) for MEO Process at the Savannah River Site						
Incinerator Ash	1.03	2.22×10^{-6}	2.41×10^{-7}	0.0463	0.00111	0.0000615
Graphite Fines	0.08	1.72×10^{-7}	1.87×10^{-8}	0.00359	0.0000862	4.78×10^{-6}
Sum	1.11	2.39×10^{-6}	2.59×10^{-7}	0.0499	0.0012	0.0000663
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon – Ash (No SS&C) Residue						
Incinerator Ash	4.00	2.56×10^{-8}	6.73×10^{-9}	0.00105	0.000085	2.77×10^{-6}
MEO Process at the Savannah River Site F-Canyon – Ash (No SS&C) Residue						
Incinerator Ash	2.16	1.75×10^{-8}	4.72×10^{-9}	0.000743	0.0000605	1.74×10^{-6}
Graphite Fines	0.17	1.38×10^{-9}	3.72×10^{-10}	0.0000585	4.76×10^{-6}	1.37×10^{-7}
Sum	2.33	1.89×10^{-8}	5.10×10^{-9}	0.000801	0.0000653	1.87×10^{-6}
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon – SS&C Residue						
SS&C	1.00	3.07×10^{-9}	8.76×10^{-10}	0.000125	0.0000104	2.69×10^{-7}
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon – Ash (No SS&C) Residue						
Incinerator Ash	15.83	6.64×10^{-8}	1.67×10^{-8}	0.00301	0.000238	0.0000181
MEO Process at the Savannah River Site H-Canyon – Ash (No SS&C) Residue						
Incinerator Ash	2.16	2.03×10^{-8}	4.94×10^{-9}	0.000936	0.000072	3.15×10^{-6}

Ash Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Graphite Fines	0.17	1.60×10^{-9}	3.89×10^{-10}	0.0000737	5.67×10	2.48×10^{-7}
Sum	2.33	2.19×10^{-8}	5.33×10^{-9}	0.00101	0.0000777	3.39×10^{-6}
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon - SS&C Residue						
SS&C	1.58	6.63×10^{-9}	1.67×10^{-9}	0.000301	0.0000237	1.81×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality SS&C = sand, slag, and crucible MEO = mediated electrochemical oxidation

[a] Sum of postulated accident scenario risks

D.3.4.1.4 Alternative 4 – Combination of Processing Technologies

Ash residue processing technologies considered for this alternative are calcination/cementation and repackaging. All ash residue (incinerator ash; sand, slag, and crucible; graphite fines; and inorganic ash) can be processed using either technology. The calcination/cementation process technology accident descriptions, consequences and risks are identical to those presented in Section D.3.4.1.1, Alternative 1 - No Action. Refer to Section D.3.4.1.1 for details.

The repackaging process will be performed at Rocky Flats in Building 707, Module E. **Table D–97** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of the repackaging of ash at Rocky Flats. **Table D–98** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the repackaging of ash residue. The risks associated with repackaging are summarized in **Table D–99** and **Table D–100**.

Table D–97 Ash Residue Accident Scenario Parameters for the Repackaging Process at Rocky Flats

Accident Scenario	Frequency (per year)	Ash Residues	HEPA Banks	Material at Risk (grams)
Explosion	0.00005	2 drums [a]	2	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [c] 4 drums [d]	 2 0	 16,320 g 6,000 g
Spill: a. Room b. Glovebox c. Loading Dock	 0.008 0.8 0.001	 1 container at the limit [e] 1 feed prep container 1 drum [f]	 2 2 0	 600 g 170 g 3,000 g
Earthquake	0.0026	5-day supply [c]	0	16,320 g
Aircraft Crash	–	The aircraft will not penetrate the building wall.	–	–

Accident Scenario	DR	ARF	RF	LPF	Release Point
Explosion	1.0	0.001	0.1	1.0	Elevated
Nuclear Criticality	–	–	–	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.5	0.1	Ground
Earthquake	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash [h]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000) for plutonium content.

[b] The wet criticality is not a viable accident scenario for the repackaging process.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 1 drum at the maximum plutonium content level.

[f] 5 containers per drum of feed.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

Table D–98 Summary of the Ash Residue Accident Doses for the Repackaging Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.4	Oxide	0.48	0.052	10,000	240	8.4
Fire (Room)	0.0979	Oxide	0.118	0.0127	2,450	58.8	2.06
Fire (Dock)	0.0018	Oxide	0.00216	0.000234	45.0	1.08	0.0378
Spill (Room)	1.20×10^{-8}	Oxide	1.92×10^{-9}	7.20×10^{-10}	0.000104	5.40×10^{-6}	1.68×10^{-9}
Spill (Glovebox)	3.40×10^{-9}	Oxide	5.44×10^{-10}	2.04×10^{-10}	0.0000296	1.53×10^{-6}	4.76×10^{-10}
Spill (Dock)	0.003	Oxide	0.0036	0.00039	75.0	1.8	0.063
Earthquake	1.29	Oxide	1.55	0.168	32,300	776	27.1

MEI = maximally exposed individual Met = meteorological data

Table D–99 Summary of Ash Residue Accident Risks for the Repackaging Process at Rocky Flats in Terms of Latent Cancer Fatalities per Year

Accident Scenario	*Accident Frequency (per year)*	*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-17}

Accident Scenario	Accident Frequency (per year)	MEI (rem)		Population (person-rem)		Worker (rem)
		95% Met	50% Met	95% Met	50% Met	50% Met
Fire (Room)	0.0005	2.94×10^{-8}	3.18×10^{-9}	0.000612	0.0000147	4.11×10^{-7}
Fire (Dock)	2.0×10^{-6}	2.16×10^{-12}	2.34×10^{-13}	4.50×10^{-8}	1.08×10^{-9}	3.02×10^{-11}
Spill (Room)	0.008	7.68×10^{-15}	2.88×10^{-15}	4.18×10^{-10}	1.67×10^{-11}	5.38×10^{-15}
Spill (Glovebox)	0.8	2.18×10^{-13}	8.16×10^{-14}	1.18×10^{-8}	6.12×10^{-10}	5.27×10^{-13}
Spill (Dock)	0.001	1.80×10^{-9}	1.95×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.0026	2.02×10^{-6}	2.18×10^{-7}	0.042	0.00101	0.0000565

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

Table D–100 Alternative 4 Accident Risks During Ash Residue Repackaging

Ash Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Incinerator Ash	1.07	2.20×10^{-6}	2.39×10^{-7}	0.0459	0.00110	0.0000611
SS&C	0.15	3.09×10^{-7}	3.35×10^{-8}	0.00644	0.000154	8.56×10^{-6}
Graphite Fines	0.09	1.85×10^{-7}	2.01×10^{-8}	0.00386	0.0000927	5.14×10^{-6}
Inorganic Ash	0.06	1.34×10^{-7}	1.24×10^{-8}	0.00257	0.0000618	3.42×10^{-6}
Sum	1.37	2.82×10^{-6}	3.06×10^{-7}	0.0588	0.00141	0.0000782

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality SS&C = sand, slag, and crucible
[a] Sum of postulated accident scenario risks

D.3.4.2 Pyrochemical Salt Residues

D.3.4.2.1 Alternative 1 – No Action

The processing technology considered for this alternative is pyro-oxidizing of the pyrochemical salt residues. The pyro-oxidizing process will be performed at Rocky Flats in Building 707, Module A.

Table D–101 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of pyro-oxidizing the pyrochemical salt residue at Rocky Flats. **Table D–102** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of pyrochemical salt residues. The risks associated with this processing technology are summarized in **Table D–103** and **Table D–104**.

Table D–101 Pyrochemical Salt Residue Accident Scenario Parameters

Accident Scenario	Frequency (per year)	Pyrochemical Salt Residues	HEPA Banks	Material at Risk (grams)		DR	ARF	RF	LPF	Release Point
				DOR Salt Residue	MR and MSE Salt Residue					
Explosion	0.00005	2 drums [a]	0	4,000 g	4,000 g	1.0	0.001	0.001	1.0	Ground

Accident Scenario	Frequency (per year)	Pyrochemical Salt Residues	HEPA Banks	Material at Risk (grams)		DR	ARF	RF	LPF	Release Point
				DOR Salt Residue	MR and MSE Salt Residue					
Nuclear Criticality [b]	–	–	–	–	–	–	–	–	–	–
Fire:										
a. Room	0.0005	5-day supply [c]	2	2,672 g	4,800 g	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	2.0×10^{-6}	4 drums [d]	0	6,000 g	6,000 g	0.01	0.006	0.01	0.5	Ground
Spill:										
a. Room	0.008	1 container at the limit [e]	2	600 g	600 g	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
b. Glovebox	0.8	1 feed prep container	2	83.5 g	150 g	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
c. Loading Dock	0.001	1 drum [f]	0	3,000 g	3,000 g	0.25	0.00008	0.001	0.1	Ground
Earthquake	0.0026	5-day supply [c]	0	2,672 g	4,800 g	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–	–	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor DOR = direct oxide reduction
ER = electrorefining MSE = molten salt extraction

[a] 1 drum at the maximum plutonium content level (3,000 grams) and 1 drum at the administrative control level (1,000 grams) for plutonium content.
[b] The wet nuclear criticality is not a viable accident scenario for the pyro-oxidizing technology assessment.
[c] 3-day supply of feed and 2-day supply of product.
[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[e] 5 containers per drum of feed.
[f] 1 drum at the maximum plutonium content level.
[g] Add 0.000192 to ARF×RF value for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

Table D–102 Summary of the Pyrochemical Salt Residue Accident Analysis Doses

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Process Direct Oxide Reduction Salt Residue							
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72
Fire (Room)	0.016	Salt-M	0.257	0.0273	4,490	107	2.89
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	3.34×10^{-12}	Salt-M	7.01×10^{-12}	2.64×10^{-12}	3.21×10^{-7}	1.64×10^{-8}	4.01×10^{-12}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.212	Salt-M	3.39	0.36	59,300	1,420	38.1
Process Electrofining and Molten Salt Extraction Salt Residue							
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72
Fire (Room)	0.0288	Salt-M	0.461	0.049	8,060	193	5.18
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	6.00×10^{-12}	Salt-M	1.26×10^{-11}	4.74×10^{-12}	5.76×10^{-7}	2.94×10^{-8}	7.20×10^{-12}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.38	Salt-M	6.08	0.646	106,000	2,550	68.4

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt

Table D–103 Summary of the Pyrochemical Salt Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Process Direct Oxide Reduction Salt Residue						
Explosion	0.00005	1.60×10^{-9}	1.70×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	6.41×10^{-8}	6.81×10^{-9}	0.00112	0.0000269	5.77×10^{-7}
Fire (Dock)	2.0×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	2.81×10^{-15}	1.06×10^{-15}	1.28×10^{-10}	6.55×10^{-12}	1.28×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	4.40×10^{-6}	4.68×10^{-7}	0.077	0.00184	0.0000792
Process Electrofining and Molten Salt Extraction Salt Residue						
Explosion	0.00005	1.60×10^{-9}	1.70×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	1.15×10^{-7}	1.22×10^{-8}	0.00202	0.0000482	1.04×10^{-6}
Fire (Dock)	2.0×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	5.04×10^{-15}	1.90×10^{-15}	2.30×10^{-10}	1.18×10^{-11}	2.30×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	7.91×10^{-6}	8.40×10^{-7}	0.138	0.00331	0.000142

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–104 Alternative 1 Accident Risks During Salt Residue Processing

Salt Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
DOR Salt (IDCs 365, 413, 427)	1.00	4.47×10^{-6}	4.75×10^{-7}	0.0782	0.00187	0.0000295
DOR Salt (All other IDCs)	0.37	1.65×10^{-6}	1.76×10^{-7}	0.0289	0.000692	0.0000798
MSE Salt (IDC 409)	0.95	7.62×10^{-6}	8.10×10^{-7}	0.133	0.00319	0.000033
ER and MSE Salt (All other IDCs)	2.30	0.0000185	1.96×10^{-6}	0.323	0.00773	0.00136
All Salt Residues	4.62	0.0000323	3.42×10^{-6}	0.563	0.0135	0.000575

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality DOR = direct oxide reduction ER = electrorefining MSE = molten salt extraction
[a] Sum of postulated accident scenario risks

D.3.4.2.2 Alternative 2 – Processing without Plutonium Separation

The pyrochemical salt residues processing technology considered for this alternative is the blend down process. The blend down process will be performed at Rocky Flats in Building 707, Modules A, D, and E. Building 371 is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process. **Table D–105** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of the pyrochemical salt processing technology at Rocky Flats. **Table D–106** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of pyrochemical salt residues. The risks associated with this processing technology are summarized in **Table D–107** and **Table D–108**.

Table D–105 Pyrochemical Salt Residue Accident Scenario Parameters

Accident Scenario	*Frequency (per year)*	*Pyrochemical Salt Residues*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	0/2 [b]	4,000 g
Nuclear Criticality [c]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [d]	2	1,650g
b. Loading Dock	2.0×10^{-6}	4 drums [e]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the limit [f]	2	600 g
b. Glovebox	0.8	1 feed prep container	2	165 g
c. Loading Dock	0.001	1 drum [g]	0	3,000 g
Earthquake:				
a. Building 707	0.0026	5-day supply [d]	0	1,650 g
b. Building 371	0.000094	5-day supply [d]	0	1,650 g
Aircraft Crash:				
a. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–
b. Building 371	0.00004	The aircraft will not penetrate the building walls.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.001	1.0	Ground
b. Building 371	1.0	0.001	0.001	2.0×10^{-6}	Elevated
Nuclear Criticality [c]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.001	0.1	Ground
Earthquake	1.0	0.002 [h]	0.3 [h]	0.1	Ground

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Aircraft Crash:					
a. Building 707 [j]	–	–	–	–	–
b. Building 371 [k]	–	–	–	–	–

DR= damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] Building 371, 2 HEPA Banks; Building 707, 0 HEPA Banks.

[c] The wet nuclear criticality is not a viable accident scenario for the blend down technology assessment.

[d] 3-day supply of feed and 2-day supply of product.

[e] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[f] 5 containers per drum of feed.

[g] 1 drum at the maximum plutonium content level.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[j] The aircraft will not penetrate the building walls.

[k] Consequences enveloped by the earthquake.

Table D–106 Summary of the Pyrochemical Salt Residue Accident Analysis Doses

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 707							
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72
Fire (Room)	0.0099	Salt-M	0.158	0.0168	2,770	66.3	1.78
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	6.60×10^{-12}	Salt-M	1.39×10^{-11}	5.21×10^{-12}	6.34×10^{-7}	3.23×10^{-8}	7.92×10^{-12}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.131	Salt-M	2.09	0.222	36,600	876	23.5

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Building 371							
Explosion	8.00×10^{-9}	Salt-M	1.52×10^{-7}	1.76×10^{-8}	0.00216	0.0000512	1.28×10^{-7}
Fire (Room)	0.00990	Salt-M	0.238	0.0238	2,770	66.3	1.78
Fire (Dock)	0.00180	Salt-M	0.0432	0.00432	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	4.56×10^{-10}	5.28×10^{-11}	6.48×10^{-6}	1.54×10^{-7}	3.84×10^{-10}
Spill (Glovebox)	6.60×10^{-12}	Salt-M	1.25×10^{-10}	1.45×10^{-11}	1.78×10^{-6}	4.22×10^{-8}	1.06×10^{-10}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000144	0.0000144	1.68	0.0402	0.00108
Earthquake	0.131	Salt-M	3.14	0.314	36,600	876	23.5

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt

Table D–107 Summary of the Pyrochemical Salt Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Building 707						
Explosion	0.00005	1.60×10^{-9}	1.70×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	3.96×10^{-8}	4.21×10^{-9}	0.000693	0.0000166	3.56×10^{-7}
Fire (Dock)	2.0×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	5.54×10^{-15}	2.09×10^{-15}	2.53×10^{-10}	1.29×10^{-11}	2.53×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	2.72×10^{-6}	2.89×10^{-7}	0.0476	0.000114	0.0000489
Building 371						
Explosion	0.00005	3.80×10^{-15}	4.40×10^{-16}	5.40×10^{-11}	1.28×10^{-12}	2.56×10^{-15}
Fire (Room)	0.0005	5.94×10^{-8}	5.94×10^{-9}	0.000693	0.0000166	3.56×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-11}	4.32×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	1.82×10^{-15}	2.11×10^{-16}	2.59×10^{-11}	6.14×10^{-13}	1.23×10^{-15}
Spill (Glovebox)	0.8	5.02×10^{-14}	5.81×10^{-15}	7.13×10^{-10}	1.69×10^{-11}	3.38×10^{-14}
Spill (Dock)	0.001	7.20×10^{-11}	7.20×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.000094	1.47×10^{-7}	1.47×10^{-8}	0.00172	0.0000412	1.77×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–108 Alternative 2 Accident Risks During Salt Residue Processing

Salt Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 707						
DOR Salt (IDCs 365, 413, 427)	1.62	4.47×10^{-6}	4.75×10^{-7}	0.0782	0.00187	0.0000799
DOR Salt (All other IDC's	0.60	1.66×10^{-6}	1.76×10^{-7}	0.029	0.000693	0.0000296
ER and MSE Salt (IDC 409)	2.76	7.62×10^{-6}	8.09×10^{-7}	0.133	0.00319	0.000136
ER and MSE Salt (All other IDCs)	6.70	0.0000185	1.96×10^{-6}	0.324	0.00774	0.00033
All Salt Residues	11.68	0.0000322	3.42×10^{-6}	0.564	0.0135	0.000576
Building 371						
DOR Salt (IDCs 365, 413, 427)	1.62	3.35×10^{-7}	3.35×10^{-8}	0.00391	0.0000936	3.44×10^{-6}
DOR Salt (All other IDCs)	0.60	1.24×10^{-7}	1.24×10^{-8}	0.00145	0.0000347	1.28×10^{-6}
ER and MSE Salt (IDC 409)	2.76	5.71×10^{-7}	5.71×10^{-8}	0.00666	0.000159	5.87×10^{-6}
ER and MSE Salt (All other IDCs)	6.70	1.39×10^{-6}	1.39×10^{-7}	0.0162	0.000387	0.0000142
All Salt Residues	11.68	$2.42\times^{-6}$	2.42×10^{-7}	0.0282	0.000675	0.0000248

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality DOR = direct oxide reduction
ER = electrorefining MSE = molten salt extraction
[a] Sum of postulated accident scenario risks

D.3.4.2.3 Alternative 3 – Processing with Plutonium Separation

The pyrochemical salt residues processing technologies considered for this alternative are salt distillation, water leach, acid dissolution, and salt scrub.

- **Salt Distillation Technology—**The salt distillation technology is only used to treat sodium chloride/ potassium chloride salts. Processing of pyrochemical salt residues with the salt distillation process may be performed at either Rocky Flats or Los Alamos National Laboratory. At Rocky Flats, the process will be performed in Building 707, Modules A and B. For processing at Los Alamos National Laboratory, the preprocessing and packaging of the residues at Rocky Flats will be performed in Building 707, Module A. The salt distillation process will be performed in Los Alamos National Laboratory Technical Area 55.

  Similar accidents are applicable to all the technologies at both of the sites. **Table D–109** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of pyrochemical salt processing with the salt distillation technology at Rocky Flats. **Table D–110** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental

releases associated with the processing of pyrochemical salt residues at Rocky Flats. The risks associated with this processing technology at Rocky Flats are summarized in **Table D–111** and **Table D–112**.

Table D–109 Pyrochemical Salt Residue Accident Scenario Parameters for the Salt Distillation Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Pyrochemical Salt Residues*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [c]	2	7,014 g
b. Loading Dock	2.0×10^{-6}	4 drums [d]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the maximum limit [e]	2	600 g
b. Glovebox	0.8	1 feed prep container	2	222 g
c. Loading Dock	0.001	1 drum [f]	0	3,000 g
Earthquake	0.0026	5-day supply [c]	0	7,014 g
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.001	1.0	Ground
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.001	0.1	Ground
Earthquake	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash [h]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the salt distillation process in Building 707.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 5 containers per drum of feed.

[f] 1 drum at the maximum plutonium content level.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

Table D–110 Summary of the Pyrochemical Salt Residue Accident Analysis Doses for the Salt Distillation Process at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72

Accident Scenario	Building Source Term		MEI (rem)		Population (person-rem)		Worker (rem)
	(grams)	Type	95% Met	50% Met	95% Met	50% Met	50% Met
Fire (Room)	0.0426	Salt-M	0.682	0.0725	11,900	286	7.67
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	8.88×10^{-12}	Salt-M	1.86×10^{-11}	7.02×10^{-12}	8.52×10^{-7}	4.35×10^{-8}	1.07×10^{-11}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.563	Salt-M	9.00	0.956	158,000	3,770	101

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt

Table D–111 Summary of the Pyrochemical Salt Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Salt Distillation Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Explosion	0.00005	1.60×10^{-9}	1.70×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	1.70×10^{-7}	1.81×10^{-8}	0.00298	0.0000714	1.53×10^{-6}
Fire (Dock)	2.00×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	7.46×10^{-15}	2.81×10^{-15}	3.41×10^{-10}	1.74×10^{-11}	3.41×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	0.0000117	1.24×10^{-6}	0.205	0.0049	0.000211

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–112 Alternative 3 Accident Risks During the Salt Distillation Process at Rocky Flats

Salt Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
ER and MSE Salt (IDC 409)	0.64	7.60×10^{-6}	8.08×10^{-7}	0.133	0.00318	0.000136
ER and MSE Salt (All other IDCs)	1.56	0.0000185	1.97×10^{-6}	0.324	0.00776	0.000331
Sum	2.20	0.0000261	2.78×10^{-6}	0.457	0.0109	0.000467

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality ER = electrorefining
MSE = molten salt extraction
[a] Sum of postulated accident scenario risks

Table D–113 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of preprocessing and packaging the pyrochemical salt residue at Rocky Flats and processing the residue using the salt distillation technology at Los Alamos National Laboratory. **Table D–114** summarizes

the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the preprocessing and packaging of the residues at Rocky Flats and the processing of pyrochemical salt residues at Los Alamos National Laboratory. The risks associated with the preprocessing and packaging at Rocky Flats and processing using the salt distillation technology at Los Alamos National Laboratory are summarized in **Table D–115** and **Table D–116**.

Table D–113 Pyrochemical Salt Residue Accident Scenario Parameters for the Salt Distillation Process at Los Alamos National Laboratory

Rocky Flats Preprocessing and Packaging of Electrorefining and Molten Salt Extraction Residue for Shipment to Los Alamos National Laboratory				
Accident Scenario	***Frequency (per year)***	***Pyrochemical Salt Residues***	***HEPA Banks***	***Material at Risk (grams)***
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [c] 4 drums [d]	 2 0	 7,104 g 6,000 g
Spill: a. Room b. Glovebox c. Loading Dock	 0.008 0.8 0.001	 1 container at the maximum limit [e] 1 feed prep container 1 drum [f]	 2 2 0	 600 g 222 g 3,000 g
Earthquake	0.0026	5-day supply [c]	0	7,104 g
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	***DR***	***ARF***	***RF***	***LPF***	***Release Point***
Explosion	1.0	0.001	0.001	1.0	Ground
Nuclear Criticality [b]	–	–	–	–	–
Fire: a. Room b. Loading Dock	 1.0 0.01	 0.006 0.006	 0.01 0.01	 0.1 0.5	 Ground Ground
Spill: a. Room b. Glovebox c. Loading Dock	 1.0 1.0 0.25	 0.00002 0.00002 0.00008	 0.001 0.001 0.001	 2.0×10^{-6} 2.0×10^{-6} 0.1	 Elevated Elevated Ground
Earthquake	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash [h]	–	–	–	–	–

Salt Distillation Processing at Los Alamos National Laboratory		
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***
Explosion [j]	–	–
Nuclear Criticality	0.0001	1.0×10^{-18} fissions
Fire	0.0005	4,112 g
Spill	0.003	3,000 g
Earthquake	0.0005	5,112 g
Aircraft Crash [k]	–	–

Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Nuclear Criticality	–	–	–	Elevated
Fire	1.0	0.00006	0.011	Ground
Spill	1.0	0.00001	4.00×10^{-9}	Elevated

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Earthquake	1.0	0.000792	0.1	Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the residue preprocessing and packaging process in Building 707.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 5 containers per drum of feed.

[f] 1 drum at the maximum plutonium content level.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

[j] Neither of the explosions postulated in the Technical Area 55 Safety Analysis Report (LANL 1996) would breach the integrity of the gloveboxes proposed for the processing of the Rocky Flats residues.

[k] The Technical Area 55 Safety Analysis Report (LANL 1996) stated that an aircraft crash into Technical Area 55 is not a credible event.

Table D–114 Summary of the Accident Analysis Doses for the Salt Distillation Process at Los Alamos National Laboratory

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Preprocessing and Packaging of Electrorefining and Molten Salt Extraction Salt Residue for Shipment to Los Alamos National Laboratory							
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72
Fire (Room)	0.0409	Salt-M	0.654	0.0695	11,500	274	7.36
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	8.52×10^{-12}	Salt-M	1.79×10^{-11}	6.73×10^{-12}	8.18×10^{-7}	4.17×10^{-8}	1.02×10^{-11}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.540	Salt-M	8.64	0.918	151,000	3,620	97.2
Salt Distillation Processing of Electrorefining and Molten Salt Extraction Salt Residue at Los Alamos National Laboratory							
Nuclear Criticality	[a]	–	0.137	0.0220	98.8	15.7	0.0450
Fire	0.00337	Salt-O	0.128	0.0165	169	17.2	1.38
Spill	1.20×10^{-10}	Salt-O	3.72×10^{-9}	5.52×10^{-10}	4.32×10^{-6}	6.24×10^{-7}	3.36×10^{-10}
Earthquake	0.405	Salt-O	15.4	1.98	20,200	2,060	166

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt Salt-O = oxide salt

[a] 1.0×10^{-18} fissions

Table D–115 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Salt Distillation Process at Los Alamos National Laboratory

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Rocky Flats Preprocessing and Packaging of Electrorefining and Molten Salt Extraction Salt Residues for Shipment to Los Alamos National Laboratory						
Explosion	0.00005	1.60×10^{-9}	1.70×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	1.64×10^{-7}	1.74×10^{-8}	0.00286	0.0000685	1.47×10^{-6}
Fire (Dock)	2.00×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	7.16×10^{-15}	2.69×10^{-15}	3.27×10^{-10}	1.67×10^{-11}	3.27×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	0.0000112	1.19×10^{-6}	0.196	0.0047	0.000202
Salt Distillation Processing of Electrorefining and Molten Salt Extraction Salt Residues at Los Alamos National Laboratory						
Nuclear Criticality	0.0001	6.85×10^{-9}	1.10×10^{-9}	4.94×10^{-6}	7.85×10^{-7}	1.80×10^{-9}
Fire	0.0005	3.21×10^{-8}	4.13×10^{-9}	0.0000422	4.30×10^{-6}	2.77×10^{-7}
Spill	0.003	5.58×10^{-16}	8.28×10^{-16}	6.48×10^{-13}	9.36×10^{-13}	4.03×10^{-16}
Earthquake	0.0005	3.85×10^{-6}	4.96×10^{-7}	0.00506	0.000516	0.0000664

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–116 Alternative 3 Accident Risks During the Salt Distillation Process at Los Alamos National Laboratory

Salt Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Preprocess Electrorefining and Molten Salt Extraction Salt Residue at Rocky Flats						
ER and MSE Salt (IDC 409)	0.67	7.63×10^{-6}	8.11×10^{-7}	0.134	0.0032	0.000136
ER and MSE Salt (All other IDCs)	1.62	0.0000185	1.96×10^{-6}	0.323	0.00773	0.00033
Sum	2.29	0.0000261	2.77×10^{-6}	0.457	0.0109	0.000466
Process Electrorefining and Molten Salt Extraction Salt Residue at Los Alamos National Laboratory						
ER and MSE Salt (IDC 409)	1.77	6.88×10^{-6}	8.87×10^{-7}	0.00904	0.000923	0.000118
ER and MSE Salt (All other IDCs)	4.20	0.0000166	2.15×10^{-6}	0.0219	0.00223	0.000285
Sum	6.05	0.0000235	3.03×10^{-6}	0.0309	0.00315	0.000403

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality ER = electrorefining
MSE = molten salt extraction
[a] Sum of postulated accident scenario risks

- **Water Leach Technology—**The water leach technology can be used to process all salt residues: direct oxide reduction salts, electrorefining salts, and molten salt extraction salts. At Rocky Flats, this process will be performed on all salts in Building 371, Room 3701. The final calcination in the process will be performed in Building 707A, Module J. The water leach technology also may be used at Los Alamos National Laboratory for the processing of direct oxide reduction salt residues. For processing at Los Alamos National Laboratory, the preprocessing and packaging of the residues at Rocky Flats will be performed in Building 707, Module A. The water leach process will be performed in Los Alamos National Laboratory Technical Area 55, Building PF-4, Room 420.

Table D–117 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of pyrochemical salt processing with the water leach technology at Rocky Flats. **Table D–118** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of pyrochemical salt residues. The risks associated with this processing technology are summarized in **Table D–119** and **Table D–120**.

Table D–117 Pyrochemical Salt Residue Accident Scenario Parameters for the Water Leach Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Pyrochemical Salt Residues*	*HEPA Banks*	*Material at Risk (grams)*		
				Process DOR Salt Residue	*Process ER and MSE Salt Residues*	*Final Calcination*
				Building 371	*Building 371*	*Building 707A* [a]
Explosion	0.00005	2 drums	2/0 [b]	4,000 g [c]	4,000 g	2,000 g
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	1.0×10^{19} fissions	N/A [d]
Fire:						
a. Room	0.0005	5-day supply [e]	2	8,148 g	8,148 g	11,000 g
b. Loading Dock	2.0×10^{-6}	4 drums	0	6,000 g [f]	6,000 g	4,000 g
Spill:						
a. Room	0.008	1 container at the maximum limit	2	600 g [g]	600 g [g]	1,000 g
b. Glovebox	0.8	1 feed prep container	2	200 g	200 g	1,000 g
c. Loading Dock	0.001	1 drum	0	3,000 g [h]	3,000 g	1,000 g
Earthquake:						
a. Building 371	0.000094	5-day supply [e]	0	8,148 g	8,148 g	N/A
b. Building 707A	0.0026	5-day supply [e]	0	N/A	N/A	11,000 g
Aircraft Crash:						
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707A	1.0	0.001	0.001	1.0	Ground
b. Building 371	1.0	0.001	0.001	2.0×10^{-6}	Elevated

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Nuclear Criticality [d, j]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.001	0.1	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.002 [k]	0.3 [k]	0.1	Ground
Aircraft Crash:					
a. Building 707A [l]	–	–	–	–	–
b. Building 371 [m]	–	–	–	–	–

DOR = direct oxide reduction ER = electrorefining MSE = molten salt extraction N/A = not applicable DR = damage ratio
ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1,000-g product containers are transported from Building 371 to Building 707A for processing.
[b] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.
[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.
[d] The wet nuclear criticality is not a viable accident scenario for the final calcination process in Building 707A.
[e] 3-day supply of feed and 2-day supply of product.
[f] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[g] 5 containers per drum of feed.
[h] 1 drum at the maximum plutonium content level.
[j] Refer to Table D–28 for Building 371 criticality accident source term.
[k] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[l] Consequences enveloped by the earthquake.
[m] The aircraft will not penetrate the building walls.

Table D–118 Summary of the Pyrochemical Salt Residue Accident Analysis Doses for the Water Leach Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Process Direct Oxide Reduction Salt Residue—Building 371							
Explosion	8.00×10^{-9}	Salt-M	1.52×10^{-7}	1.76×10^{-8}	0.00216	0.0000512	1.28×10^{-7}
Criticality (Liquid)	[a]	–	0.79	0.11	6,980	252	0.321
Fire (Room)	0.0489	Salt-M	1.17	0.117	13,700	328	8.80
Fire (Dock)	0.0018	Salt-M	0.0432	0.00432	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	4.56×10^{-10}	5.28×10^{-11}	6.48×10^{-6}	1.54×10^{-7}	3.84×10^{-10}
Spill (Glovebox)	8.00×10^{-12}	Salt-M	1.52×10^{-10}	1.76×10^{-11}	2.16×10^{-6}	5.12×10^{-8}	1.28×10^{-10}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000144	0.0000144	1.68	0.0402	0.00108
Earthquake	0.645	Salt-M	15.5	1.55	181,000	4,320	116
Process Electrorefining and Molten Salt Extraction Salt Residues—Building 371							
Explosion	8.00×10^{-9}	Salt-M	1.52×10^{-7}	1.76×10^{-8}	0.00216	0.0000512	1.28×10^{-7}

Accident Scenario	Building Source Term (grams)	Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Criticality (Liquid)	[a]	–	0.79	0.11	6,980	252	0.321
Fire (Room)	0.0489	Salt-M	1.17	0.117	13,700	328	8.80
Fire (Dock)	0.0018	Salt-M	0.0432	0.00432	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	4.56×10^{-10}	5.28×10^{-11}	6.48×10^{-6}	1.54×10^{-7}	3.84×10^{-10}
Spill (Glovebox)	8.00×10^{-12}	Salt-M	1.52×10^{-10}	1.76×10^{-11}	2.16×10^{-6}	5.12×10^{-8}	1.28×10^{-10}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000144	0.0000144	1.68	0.0402	0.00108
Earthquake	0.645	Salt-M	15.5	1.55	181,000	4,320	116
Final Calcination—Building 707A							
Explosion	0.002	Salt-O	0.028	0.003	520	12.4	0.34
Fire (Room)	0.066	Salt-O	0.924	0.099	17,200	409	11.2
Fire (Dock)	0.0012	Salt-O	0.0168	0.0018	312	7.44	0.204
Spill (Room)	4.00×10^{-11}	Salt-O	7.60×10^{-11}	2.88×10^{-11}	3.60×10^{-6}	1.84×10^{-7}	4.80×10^{-11}
Spill (Glovebox)	4.00×10^{-11}	Salt-O	7.60×10^{-11}	2.88×10^{-11}	3.60×10^{-6}	1.84×10^{-7}	4.80×10^{-11}
Spill (Dock)	2.00×10^{-6}	Salt-O	0.000028	3.00×10^{-6}	0.52	0.0124	0.00034
Earthquake	0.871	Salt-O	12.2	1.31	227,000	5,400	148

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt Salt-O = oxide salt
[a] 1.0×10^{19} fissions.

Table D–119 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Water Leach Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Process Direct Oxide Reduction Salt Residues—Building 371						
Explosion	0.00005	3.80×10^{-15}	4.40×10^{-16}	5.40×10^{-11}	1.28×10^{-12}	2.56×10^{-15}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	2.93×10^{-7}	2.93×10^{-8}	0.00342	0.0000819	1.76×10^{-6}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-11}	4.32×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	1.82×10^{-15}	2.11×10^{-16}	2.59×10^{-11}	6.14×10^{-13}	1.23×10^{-15}
Spill (Glovebox)	0.8	6.08×10^{-14}	7.04×10^{-15}	8.64×10^{-10}	2.05×10^{-11}	4.10×10^{-14}
Spill (Dock)	0.001	7.20×10^{-11}	7.20×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.000094	7.28×10^{-7}	7.28×10^{-8}	0.00849	0.000203	8.74×10^{-6}
Process Electrorefining and Molten Salt Extraction Salt Residues—Building 371						
Explosion	0.00005	3.80×10^{-15}	4.40×10^{-16}	5.40×10^{-11}	1.28×10^{-12}	2.56×10^{-15}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Fire (Room)	0.0005	2.93×10^{-7}	2.93×10^{-8}	0.00342	0.0000819	1.76×10^{-6}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-11}	4.32×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	1.82×10^{-15}	2.11×10^{-16}	2.59×10^{-11}	6.14×10^{-13}	1.23×10^{-15}
Spill (Glovebox)	0.8	6.08×10^{-14}	7.04×10^{-15}	8.64×10^{-10}	2.05×10^{-11}	4.10×10^{-14}
Spill (Dock)	0.001	7.20×10^{-11}	7.20×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.000094	7.28×10^{-7}	7.28×10^{-8}	0.00849	0.000203	8.74×10^{-6}
Final Calcination—Building 707A						
Explosion	0.00005	7.00×10^{-10}	7.50×10^{-11}	0.000013	3.10×10^{-7}	6.80×10^{-9}
Fire (Room)	0.0005	2.31×10^{-7}	2.48×10^{-8}	0.00429	0.000102	2.24×10^{-6}
Fire (Dock)	2.0×10^{-6}	1.68×10^{-11}	1.80×10^{-12}	3.12×10^{-7}	7.44×10^{-9}	1.63×10^{-10}
Spill (Room)	0.008	3.04×10^{-16}	1.15×10^{-16}	1.44×10^{-11}	7.36×10^{-13}	1.54×10^{-16}
Spill (Glovebox)	0.8	3.04×10^{-14}	1.15×10^{-14}	1.44×10^{-9}	7.36×10^{-11}	1.54×10^{-14}
Spill (Dock)	0.001	1.40×10^{-11}	1.50×10^{-12}	2.60×10^{-7}	6.20×10^{-9}	1.36×10^{-10}
Earthquake	0.0026	0.0000159	1.70×10^{-6}	0.294	0.00702	0.000308

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data DOR = direct oxide reduction

Table D–120 Alternative 3 Accident Risks During the Water Leach Process at Rocky Flats

Salt Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Process Direct Oxide Reduction Salt Residue – Building 371						
IDCs 365, 413, 427	0.33	3.50×10^{-7}	3.55×10^{-8}	0.00405	0.0000983	3.47×10^{-6}
All other IDCs	0.12	1.27×10^{-7}	1.29×10^{-8}	0.00147	0.0000357	1.26×10^{-6}
Sum	0.45	4.77×10^{-7}	4.84×10^{-8}	0.00552	0.000134	4.73×10^{-6}
Process Direct Oxide Reduction Salt Residue – Building 707A						
IDCs 365, 413, 427	0.25	4.02×10^{-6}	4.31×10^{-7}	0.0747	0.00178	0.0000776
All other IDCs	0.09	1.45×10^{-6}	1.55×10^{-7}	0.0269	0.000641	0.0000279
Sum	0.34	5.47×10^{-6}	5.86×10^{-7}	0.102	0.00242	0.0000106
Process Direct Oxide Reduction Salt Residue – Buildings 371 and 707A						
IDCs 365, 413, 427	0.58	4.37×10^{-6}	4.66×10^{-7}	0.0787	0.00188	0.000081
All other IDCs	0.21	1.58×10^{-6}	1.68×10^{-7}	0.0284	0.000677	0.0000292
Sum	0.79	5.95×10^{-6}	6.34×10^{-7}	0.107	0.00256	0.00011
Process Electrorefining and Molten Salt Extraction Salt Residue – Building 371						
IDCs 365, 413, 427	0.56	5.94×10^{-7}	6.03×10^{-8}	0.00687	0.000167	5.88×10^{-6}
All other IDCs	1.34	1.42×10^{-6}	1.44×10^{-7}	0.0164	0.000399	0.0000141
Sum	1.90	2.02×10^{-6}	2.05×10^{-7}	0.0233	0.000566	0.00002
Process Electrorefining and Molten Salt Extraction Salt Residue – Building 707A						
IDCs 365, 413, 427	0.42	6.76×10^{-6}	7.24×10^{-7}	0.125	0.00299	0.00013
All other IDCs	1.01	0.0000162	1.74×10^{-6}	0.302	0.0072	0.000313
Sum	1.43	0.000023	2.46×10^{-6}	0.427	0.0102	0.000444
Process Electrorefining and Molten Salt Extraction Salt Residue – Buildings 371 and 707A						
IDCs 365, 413, 427	0.98	7.35×10^{-6}	7.84×10^{-7}	0.132	0.00316	0.000136
All other IDCs	2.35	0.0000177	1.89×10^{-6}	0.318	0.00759	0.000327
Sum	3.33	0.0000251	2.67×10^{-6}	0.45	0.0108	0.000463

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

Table D–121 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of preprocessing and packaging the direct oxide reduction salt residue at Rocky Flats and of processing the residue using the water leach technology at Los Alamos National Laboratory. **Table D–122** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the preprocessing and packaging of the residues at Rocky Flats and the processing of the pyrochemical salt residues at Los Alamos National Laboratory. The risks associated with the preprocessing and packaging at Rocky Flats and the processing using water leach technology at Los Alamos National Laboratory are summarized in **Table D–123** and **Table D–124**.

Table D–121 Pyrochemical Salt Residue Accident Scenario Parameters for the Water Leach Process at Los Alamos National Laboratory

Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Residue for Shipment to Los Alamos National Laboratory

Accident Scenario	*Frequency (per year)*	*Pyrochemical Salt Residues*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [c] 4 drums [d]	 2 0	 6,560 g 6,000 g
Spill: a. Room b. Glovebox c. Loading Dock	 0.008 0.8 0.001	 1 container at the maximum limit [e] 1 feed prep container 1 drum [f]	 2 2 0	 600 g 205 g 3,000 g
Earthquake	0.0026	5-day supply [c]	0	6,560 g
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Residues for Shipment to Los Alamos National Laboratory

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.001	1.0	Ground
Nuclear Criticality [b]	–	–	–	–	–
Fire: a. Room b. Loading Dock	 1.0 0.01	 0.006 0.006	 0.01 0.01	 0.1 0.5	 Ground Ground
Spill: a. Room b. Glovebox c. Loading Dock	 1.0 1.0 0.25	 0.00002 0.00002 0.00008	 0.001 0.001 0.001	 2.0×10^{-6} 2.0×10^{-6} 0.1	 Elevated Elevated Ground
Earthquake	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash [h]	–	–	–	–	–

Water Leach Processing of Direct Oxide Reduction Residues at Los Alamos National Laboratory

Accident Scenario	*Frequency (per year)*	*Material at Risk (grams)*
Explosion [j]	–	–
Nuclear Criticality	0.0001	1.0×10^{18} fissions
Fire	0.0005	1,000 g slurry 5,000 g powder
Spill	0.003	205 g
Earthquake	0.0005	1,000 g slurry 5,000 g powder
Aircraft Crash [k]	–	–

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Nuclear Criticality	–	–	–	Elevated
Fire: a. Powder b. Slurry	 1.0 1.0	 0.00006 0.00006	 0.011 0.011	 Ground Ground
Spill	1.0	0.00001	4.00×10^{-9}	Elevated
Earthquake: a. Powder b. Slurry	 1.0 1.0	 0.000792 7.00×10^{-6}	 0.1 0.1	 Ground Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the residue preprocessing and packaging process in Building707.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 5 containers per drum of feed.

[f] 1 drum at the maximum plutonium content level.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

[j] Neither of the explosions postulated in the Technical Area 55 Safety Analysis Report (LANL 1996) would breach the integrity of the gloveboxes proposed for the processing of the Rocky Flats residues.

[k] The Technical Area 55 Safety Analysis Report (LANL 1996) stated that an aircraft crash into Technical Area 55 is not a credible event.

Table D–122 Summary of the Accident Analysis Doses for the Water Leach Process at Los Alamos National Laboratory

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Salt Residues for Shipment to Los Alamos National Laboratory							
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72
Fire (Room)	0.0394	Salt-M	0.63	0.0669	11,000	264	7.08
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	8.20×10^{-12}	Salt-M	1.72×10^{-11}	6.48×10^{-12}	7.87×10^{-7}	4.02×10^{-8}	9.84×10^{-12}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.52	Salt-M	8.31	0.883	145,000	3,480	93.5
Water Leach Processing of Direct Oxide Reduction Salt Residues at Los Alamos National Laboratory							
Criticality	[a]	–	0.137	0.0220	98.8	15.7	0.0450
Fire	0.00396	Salt-O	0.150	0.0194	198	20.2	1.62
Spill	8.20×10^{-12}	Salt-O	2.54×10^{-10}	3.77×10^{-11}	2.95×10^{-7}	4.26×10^{-8}	2.30×10^{-11}
Earthquake	0.397	Salt-O	15.1	1.94	19,800	2,020	163

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt Salt-O = oxide salt

[a] 1.0×10^{18} fissions.

Table D–123 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Water Leach Process at Los Alamos National Laboratory

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Salt Residues for Shipment to Los Alamos National Laboratory						
Explosion	0.00005	1.60×10^{-9}	1.70×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	1.57×10^{-7}	1.67×10^{-8}	0.00276	0.0000659	1.42×10^{-6}
Fire (Dock)	2.00×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	6.89×10^{-15}	2.59×10^{-15}	3.15×10^{-10}	1.61×10^{-11}	3.15×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	0.0000108	1.15×10^{-6}	0.189	0.00453	0.000195
Water Leach Processing of Direct Oxide Reduction Salt Residues at Los Alamos National Laboratory						
Criticality	0.0001	6.85×10^{-9}	1.10×10^{-9}	4.94×10^{-6}	7.85×10^{-7}	1.80×10^{-9}
Fire	0.0005	3.76×10^{-8}	4.85×10^{-9}	0.0000495	5.05×10^{-6}	3.25×10^{-7}
Spill	0.003	3.81×10^{-16}	5.66×10^{-17}	4.43×10^{-13}	6.40×10^{-14}	2.76×10^{-17}
Earthquake	0.0005	3.77×10^{-6}	4.86×10^{-7}	0.00496	0.000506	0.0000651

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–124 Alternative 3 Accident Risks During the Water Leach Process at Los Alamos National Laboratory

Salt Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Preprocess Direct Oxide Reduction Salt Residue at Rocky Flats						
IDCs 365, 413, 427	0.41	4.50×10^{-6}	4.78×10^{-7}	0.0787	0.00188	0.0000803
All other IDCs	0.15	1.64×10^{-6}	1.75×10^{-7}	0.0288	0.000689	0.0000294
Sum	0.56	6.14×10^{-6}	6.52×10^{-7}	0.107	0.00257	0.00011
Process Direct Oxide Reduction Salt Residue at Los Alamos National Laboratory						
IDCs 365, 413, 427	0.8	3.05×10^{-6}	3.94×10^{-7}	0.00401	0.000409	0.0000523
All other IDCs	0.3	1.14×10^{-6}	1.48×10^{-7}	0.0015	0.000153	0.0000196
Sum	1.1	4.19×10^{-6}	5.41×10^{-7}	0.00551	0.000563	0.0000719

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

❒ **Acid Dissolution Technology—**The acid dissolution technology can be used to process direct oxide reduction salts. This process will be performed in gloveboxes at the Los Alamos National Laboratory

Technical Area 55, Building PF-4, Room 420. Preprocessing and packaging of the residues at Rocky Flats will be performed in Building 707A, Module A.

Table D–125 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of preprocessing and packaging the direct oxide reduction salt residue at Rocky Flats and of processing the residue using the acid dissolution technology at Los Alamos National Laboratory. **Table D–126** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the preprocessing and packaging of the residues at Rocky Flats and the processing of the pyrochemical salt residues at Los Alamos National Laboratory. The risks associated with the preprocessing and packaging at Rocky Flats and the processing using acid dissolution technology at Los Alamos National Laboratory are summarized in **Table D–127** and **Table D–128**.

Table D–125 Pyrochemical Salt Residue Accident Scenario Parameters for the Acid Dissolution Process at Los Alamos National Laboratory

Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Residue for Shipment to Los Alamos National Laboratory

Accident Scenario	*Frequency (per year)*	*Pyrochemical Salt Residues*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [c]	2	6,560 g
b. Loading Dock	2.0×10^{-6}	4 drums [d]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the maximum limit [e]	2	600 g
b. Glovebox	0.8	1 feed prep container	2	205 g
c. Loading Dock	0.001	1 drum [f]	0	3,000 g
Earthquake	0.0026	5-day supply [c]	0	6,560 g
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Residues for Shipment to Los Alamos National Laboratory

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.001	1.0	Ground
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.001	0.1	Ground
Earthquake	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash [h]	–	–	–	–	–

Acid Dissolution Processing of Direct Oxide Reduction Residues at Los Alamos National Laboratory

Accident Scenario	*Frequency (per year)*	*Material at Risk (grams)*
Explosion [j]	–	–
Nuclear Criticality	0.0001	1.0×10^{18} fissions

Acid Dissolution Processing of Direct Oxide Reduction Residues at Los Alamos National Laboratory				
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***		
Fire	0.0005	4,100 g		
Spill	0.003	205 g		
Earthquake	0.0005	4,100 g		
Aircraft Crash [k]	–	–		
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Nuclear Criticality	–	–	–	Elevated
Fire	1.0	0.00006	0.011	Ground
Spill	1.0	0.00001	4.00×10^{-9}	Elevated
Earthquake	1.0	0.000792	0.1	Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the residue preprocessing and packaging process in Building707.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 5 containers per drum of feed.

[f] 1 drum at the maximum plutonium content level.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

[j] Neither of the explosions postulated in the Technical Area 55 Safety Analysis Report (LANL 1996) would breach the integrity of the gloveboxes proposed for the processing of the Rocky Flats residues.

[k] The Technical Area 55 Safety Analysis Report (LANL 1996) stated that an aircraft crash into Technical Area 55 is not a credible event.

Table D–126 Summary of the Accident Analysis Doses for the Acid Dissolution Process at Los Alamos National Laboratory

	Building Source Term		***MEI (rem)***		***Population (person-rem)***		***Worker (rem)***
Accident Scenario	***(grams)***	***Type***	***95% Met***	***50% Met***	***95% Met***	***50% Met***	***50% Met***
Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Salt Residues for Shipment to Los Alamos National Laboratory							
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72
Fire (Room)	0.0394	Salt-M	0.63	0.0669	11,000	264	7.08
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	8.20×10^{-12}	Salt-M	1.72×10^{-11}	6.48×10^{-12}	7.87×10^{-7}	4.02×10^{-8}	9.84×10^{-12}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.52	Salt-M	8.31	0.883	145,000	3,480	93.5
Acid Dissolution Processing of Direct Oxide Reduction Salt Residues at Los Alamos National Laboratory							
Criticality	[a]	–	0.137	0.0220	98.8	15.7	0.0450
Fire	0.00271	Salt-O	0.103	0.0133	135	13.8	1.11
Spill	8.20×10^{-12}	Salt-O	2.54×10^{-10}	3.77×10^{-11}	2.95×10^{-7}	4.26×10^{-8}	2.30×10^{-11}
Earthquake	0.325	Salt-O	12.3	1.59	16,200	1,660	133

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt Salt-O = oxide salt
[a] 1.0×10^{18} fissions.

Table D–127 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Acid Dissolution Process at Los Alamos National Laboratory

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Preprocessing and Packaging of Direct Oxide Reduction Salt Residues for Shipment to Los Alamos National Laboratory						
Explosion	0.00005	1.60×10^{-9}	1.70×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	1.57×10^{-7}	1.67×10^{-8}	0.00276	0.0000659	1.42×10^{-6}
Fire (Dock)	2.00×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	6.89×10^{-15}	2.59×10^{-15}	3.15×10^{-10}	1.61×10^{-11}	3.15×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	0.0000108	1.15×10^{-6}	0.189	0.00453	0.000195
Acid Dissolution Processing of Direct Oxide Reduction Salt Residues at Los Alamos National Laboratory						
Criticality	0.0001	6.85×10^{-9}	1.10×10^{-9}	4.94×10^{-6}	7.85×10^{-7}	1.80×10^{-9}
Fire	0.0005	2.57×10^{-8}	3.31×10^{-9}	0.0000338	3.45×10^{-6}	2.22×10^{-7}
Spill	0.003	3.81×10^{-16}	5.66×10^{-17}	4.43×10^{-13}	6.40×10^{-14}	2.76×10^{-17}
Earthquake	0.0005	3.08×10^{-6}	3.98×10^{-7}	0.00406	0.000414	0.0000533

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–128 Alternative 3 Accident Risks During the Acid Dissolution Process at Los Alamos National Laboratory

Salt Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Preprocess Direct Oxide Reduction Salt Residue at Rocky Flats						
IDCs 365, 413, 427	0.41	4.50×10^{-6}	4.78×10^{-7}	0.0787	0.00188	0.0000803
All other IDCs	0.15	1.64×10^{-6}	1.75×10^{-7}	0.0288	0.000689	0.0000294
Sum	0.56	6.14×10^{-6}	6.52×10^{-7}	0.107	0.00257	0.00011
Process Direct Oxide Reduction Salt Residue at Los Alamos National Laboratory						
IDCs 365, 413, 427	0.64	2.00×10^{-6}	2.57×10^{-7}	0.00262	0.000268	0.0000342
All other IDCs	0.24	7.48×10^{-7}	9.65×10^{-8}	0.000983	0.0001	0.0000128
Sum	0.88	2.74×10^{-6}	3.54×10^{-7}	0.00361	0.000368	0.000471

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality IDC = item description code
[a] Sum of postulated accident scenario risks

❒ **Salt Scrub Technology—**The salt scrub technology can be used to process all pyrochemical salt residues. Implementation of this technology requires processing of the residues in Rocky Flats Building 707, Modules A and B. The scrub alloy byproduct of the process will be sent to the Savannah River Site F-Canyon or H-Canyon for final processing.

Table D–129 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of pyrochemical salt processing with the salt scrub technology at Rocky Flats and the Savannah River Site. **Table D–130** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of pyrochemical salt residues. The risks associated with this processing technology are summarized in **Table D–131** and **Table D–132**. The processes at the Savannah River Site can be performed in either the F-Canyon and FB-Line or the H-Canyon and HB-Line. Data are presented in Table D–129, Table D–130, Table D–131, and Table D–132 for both options.

Table D–129 Pyrochemical Salt Residue Accident Scenario Parameters for the Salt Scrub Process at Rocky Flats and the Savannah River Site

Accident Scenario	*Frequency (per year)*	*Pyrochemical Salt Residues*	*HEPA Banks*	*Material at Risk (grams)*
Salt Scrub at Rocky Flats				
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [c]	2	7,403 g feed 4,693 g product [d]
b. Loading Dock	2.0×10^{-6}	4 drums [e]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the maximum limit [f]	2	600 g
b. Glovebox	0.8	1 feed prep container	2	168 g
c. Loading Dock	0.001	1 drum [g]	0	3,000 g
Earthquake	0.0026	5-day supply [c]	0	7,403 g feed 4,693 g product [d]
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.001	1.0	Ground
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room					
Feed	1.0	0.006	0.01	0.1	Ground
Product	0.01	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.001	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.001	0.1	Ground
Earthquake:					
a. Feed	1.0	0.002 [h]	0.3 [h]	0.1	Ground
b. Product	0.01	0.001 [j]	0.1 [j]	0.1	Ground
Aircraft Crash [k]	–	–	–	–	–

Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon				
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***		
Explosion: a. Hydrogen b. Ion Exchange Column	 0.000015 0.0001	 8,000 g 241 mg [l]		
Nuclear Criticality [m]	0.0001	1.0×10^{19} fissions		
Fire	0.00061	8,000 g		
Spill [n]	–	–		
Earthquake: a. F-Canyon: Liquid b. FB-Line: Powder Molten Metal Liquid	0.000125	 24,000 g 2,000 g 2,000 g 2,000 g		
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion: a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.001 1.0	 0.005 1.0	 Elevated Elevated
Nuclear Criticality [m]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill [n]	–	–	–	–
Earthquake: a. F-Canyon: Liquid b. FB-Line: Powder Molten Metal Liquid	 1.0 1.0 1.0 1.0	 0.000047 0.002 0.0022 0.000047	 0.1 0.1 0.1 0.1	 Ground Ground Ground Ground
Purex Process/Plutonium Oxide Recovery at the Savannah River Site H-Canyon				
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***		
Explosion: a. Hydrogen b. Ion Exchange Column	 0.000015 0.0001	 6,000 g 241 mg [l]		
Nuclear Criticality [m]	0.0001	1.0×10^{19} fissions		
Fire	0.00061	6,000 g		
Spill [n]	–	–		
Earthquake: a. H-Canyon b. HB-Line: Powder Liquid	0.000182	 18,000 g 4,000 g 4,000 g		
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion: a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.001 1.0	 0.005 1.0	 Elevated Elevated
Nuclear Criticality [m]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill [n]	–	–	–	–

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Earthquake:				
a. H-Canyon:				
Liquid	1.0	0.000047	0.1	Ground
b. HB-Line:				
Powder	1.0	0.002	0.1	Ground
Liquid	1.0	0.000047	0.1	Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the salt scrub and pyro-oxidizing processes in Building 707.

[c] 3-day supply of feed and 2-day supply of product.

[d] 97% (4,693 g) of the product is in alloy form and 3% (145 g) is in salt form. The 145 g in salt form was added to the feed supply.

[e] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[f] 5 containers per drum of feed.

[g] 1 drum at the maximum plutonium content level.

[h] Add 0.000192 to ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[j] Add 0.000192 to ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).

[k] Consequences enveloped by the earthquake.

[l] Respirable source term value in milligrams of plutonium released up the stack.

[m] Refer to Table D–28 for criticality accident source term.

[n] Powder spill is not a viable accident scenario for processing salt residue at the Savannah River Site.

Table D–130 Summary of the Accident Analysis Doses for the Salt Scrub Process at Rocky Flats and the Savannah River Site

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Salt Scrub Process							
Explosion	0.004	Salt-M	0.064	0.0068	1,120	26.8	0.72
Fire (Room)	0.0447	Salt-M	0.715	0.076	12,500	299	8.05
Fire (Dock)	0.0018	Salt-M	0.0288	0.00306	504	12.1	0.324
Spill (Room)	2.40×10^{-11}	Salt-M	5.04×10^{-11}	1.90×10^{-11}	2.30×10^{-6}	1.18×10^{-7}	2.88×10^{-11}
Spill (Glovebox)	6.72×10^{-12}	Salt-M	1.41×10^{-11}	5.31×10^{-12}	6.45×10^{-7}	3.29×10^{-8}	8.06×10^{-12}
Spill (Dock)	6.00×10^{-6}	Salt-M	0.000096	0.0000102	1.68	0.0402	0.00108
Earthquake	0.588	Salt-M	9.40	0.999	165,000	3,940	106
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon							
Explosion (Hydrogen)	0.04	Salt-M	0.0088	0.00328	480	40.0	0.0264
Explosion (Ion Exchange)	0.241	Salt-FB	0.00771	0.00265	386	36.2	0.0231
Criticality (Liquid)	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.4	Salt-M	0.0880	0.0328	4,800	400	0.264
Earthquake	0.962	Salt-M	0.577	0.106	20,200	1,440	144

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Purex Process/Plutonium Oxide Recovery at the Savannah River Site H-Canyon							
Explosion (Hydrogen)	0.03	Salt-M	0.0063	0.00189	330	28.8	0.0198
Explosion (Ion Exchange)	0.241	Salt-HB	0.00747	0.00205	354	34.7	0.0231
Criticality (Liquid)	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.3	Salt-M	0.0630	0.0189	3,300	288	0.198
Earthquake	0.903	Salt-M	0.407	0.0813	18,100	1,170	136

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt Salt-FB = FB-Line salt
Salt-HB = HB-Line salt
[a] 1.0×10^{19} fissions.

Table D–131 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Salt Scrub Process at Rocky Flats and the Savannah River Site

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Salt Scrub Process						
Explosion	0.00005	1.60×10^{-9}	1.71×10^{-10}	0.000028	6.70×10^{-7}	1.44×10^{-8}
Fire (Room)	0.0005	1.79×10^{-7}	1.90×10^{-8}	0.00313	0.0000749	1.61×10^{-6}
Fire (Dock)	2.0×10^{-6}	2.88×10^{-11}	3.06×10^{-12}	5.04×10^{-7}	1.21×10^{-8}	2.59×10^{-10}
Spill (Room)	0.008	2.02×10^{-16}	7.58×10^{-17}	9.22×10^{-12}	4.70×10^{-13}	9.22×10^{-17}
Spill (Glovebox)	0.8	5.64×10^{-15}	2.12×10^{-15}	2.58×10^{-10}	1.32×10^{-11}	2.58×10^{-15}
Spill (Dock)	0.001	4.80×10^{-11}	5.10×10^{-12}	8.40×10^{-7}	2.01×10^{-8}	4.32×10^{-10}
Earthquake	0.0026	0.0000122	1.30×10^{-6}	0.214	0.00512	0.00022
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon						
Explosion (Hydrogen)	0.000015	6.60×10^{-11}	2.46×10^{-11}	3.60×10^{-6}	3.00×10^{-7}	1.58×10^{-10}
Explosion (Ion Exchange)	0.0001	3.86×10^{-10}	1.33×10^{-10}	0.0000193	1.81×10^{-6}	9.25×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.0000155	1.60×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.68×10^{-8}	1.00×10^{-8}	0.00146	0.000122	6.44×10^{-8}
Earthquake	0.000125	3.61×10^{-8}	6.62×10^{-9}	0.00126	0.0000902	0.0000144
Purex Process/Plutonium Oxide Recovery at the Savannah River Site H-Canyon						
Explosion (Hydrogen)	0.000015	4.73×10^{-11}	1.42×10^{-11}	2.48×10^{-6}	2.16×10^{-7}	1.19×10^{-10}
Explosion (Ion Exchange)	0.0001	3.74×10^{-10}	1.02×10^{-10}	0.0000177	1.74×10^{-6}	9.25×10^{-10}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Criticality (Liquid)	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	1.92×10^{-8}	5.76×10^{-9}	0.00101	0.0000878	4.83×10^{-8}
Earthquake	0.000182	3.70×10^{-8}	7.40×10^{-9}	0.00164	0.000107	0.0000197

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–132 Alternative 3 Accident Risks During the Salt Scrub Process at Rocky Flats and the Purex Process at Savannah River Site

Salt Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Salt Scrub at Rocky Flats						
DOR Salt (IDCs 365, 413, 427)	0.22	2.73×10^{-6}	2.90×10^{-7}	0.0478	0.00114	0.0000488
DOR Salt (all other IDCs)	0.08	9.92×10^{-7}	1.05×10^{-7}	0.0174	0.000416	0.0000177
MSE Salt (IDC 409)	0.38	4.71×10^{-6}	5.01×10^{-7}	0.0825	0.00197	0.0000842
ER and MSE Salt (all other IDCs)	0.91	0.0000113	1.20×10^{-6}	0.198	0.00473	0.000202
All Salt Residues	1.59	0.0000197	2.10×10^{-6}	0.345	0.00826	0.000352
Purex/Plutonium Metal Recovery at Savannah River Site F-Canyon						
DOR Salt (IDCs 365, 413, 427)	0.22	1.41×10^{-8}	3.74×10^{-9}	0.000608	0.0000475	3.19×10^{-6}
DOR Salt (all other IDCs)	0.08	5.11×10^{-9}	1.36×10^{-9}	0.000221	0.0000173	1.16×10^{-6}
MSE Salt (IDC 409)	0.37	2.37×10^{-8}	6.29×10^{-9}	0.00102	0.0000799	5.37×10^{-6}
ER and MSE Salt (all other IDCs)	0.91	5.82×10^{-8}	1.55×10^{-8}	0.00252	0.000196	0.0000132
All Salt Residues	1.58	1.01×10^{-7}	2.69×10^{-8}	0.00437	0.000341	0.0000229
Purex/Plutonium Oxide Recovery at Savannah River Site H-Canyon						
DOR Salt (IDCs 365, 413, 427)	0.31	1.77×10^{-8}	4.16×10^{-9}	0.000832	0.0000614	6.13×10^{-6}
DOR Salt (all other IDCs)	0.12	6.85×10^{-9}	1.61×10^{-9}	0.000322	0.0000238	2.37×10^{-6}
MSE Salt (IDC 409)	0.53	3.03×10^{-8}	7.12×10^{-9}	0.00142	0.000105	0.0000105
ER and MSE Salt (all other IDCs)	1.29	6.36×10^{-8}	1.73×10^{-8}	0.00346	0.000256	0.0000255
All Salt Residues	2.25	1.28×10^{-7}	3.02×10^{-8}	0.00604	0.000446	0.0000445

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality DOR = direct oxide reduction
ER = electrorefining MSE = molten salt extraction
[a] Sum of postulated accident scenario risks

D.3.4.2.4 Alternative 4 – Combination of Processing Technologies

The salt residue processing technology considered for this alternative is repackaging. All salt residue (direct oxide reduction, molten salt extraction, and electrorefining) can be processed using this technology. Some of the salt residue may rerquire pyro-oxidation prior to repackaging. For the puropse of this analysis, it is assumed that all the salt residue will require pyro-oxidation prior to repackaging. The pyro-oxidation and repackaging process technology accident descriptions, consequences and risks are identical to those presented in Section D.3.4.2.1, Alternative 1 - No Action. Refer to Section D.3.4.2.1 for details.

D.3.4.3 Combustible Residues

D.3.4.3.1 Alternative 1 – No Action

The combustible residues processing technologies considered for this alternative are the neutralization process for the aqueous - contaminated residue, the thermal desorption/steam passivation process for the organic - contaminated residue, and the repackaging process for the dry residue. The neutralization and thermal desorption/steam passivation processes will be performed at Rocky Flats in Building 371, Room 3701. The repackaging process will be performed at Rocky Flats in Building 707, Modules D, E, and F.

Table D–133 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of the processing technologies of combustible residues at Rocky Flats. **Table D–134** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of combustible residues. The risks associated with these processing technologies are summarized in **Table D–135** and **Table D–136**.

Table D–133 Combustible Residue Accident Scenario Parameters at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Combustible Residues*	*HEPA Banks*	*Material at Risk (grams)*		
				Neutralization Process Building 371	*Desorption and Passivation Process Building 371*	*Repackaging Process Building 707*
Explosion	0.00005	2 drums [a]	2/0 [b]	1,000 g	1,000 g	1,000 g
Nuclear Criticality [c]	–	–	–	–	–	–
Fire:						
a. Room	0.0005	5-day supply [d]	2	1,218 g	325 g	4,455 g
b. Loading Dock	2.0×10^{-6}	4 drums [a]	0	2,000 g	2,000 g	2,000 g
Spill:						
a. Room [e]	–	–		–	–	–
b. Glovebox	0.8	1 feed prep container	2	87 g	23.2 g	23.2 g
c. Loading Dock	0.001	1 drum [a]	0	500 g	500 g	500 g
Earthquake:						
a. Building 371	0.000094	5-day supply [d]	0	1,218 g	325 g	N/A
b. Building 707	0.0026	5-day supply [d]	0	N/A	N/A	4,455 g

Accident Scenario	Frequency (per year)	Combustible Residues	HEPA Banks	Material at Risk (grams)		
				Neutralization Process Building 371	Desorption and Passivation Process Building 371	Repackaging Process Building 707
Aircraft Crash:						
a Building 371	0.00003	Consequences enveloped by the earthquake.	–	–	–	–
b. Building 707	0.00004	The aircraft will not penetrate the building wall.	–	–	–	–

Accident Scenario	DR	ARF	RF	LPF	Release Point
Explosion:					
a. Building 371	1.0	0.001	0.1	2.0×10^{-6}	Elevated
b. Building 707	1.0	0.001	0.1	1.0	Ground
Nuclear Criticality [c]	–	–	–	–	–
Fire:					
a. Room	1.0	0.0005	1.0	0.1	Ground
b. Loading Dock	1.0	0.0005	1.0	0.5	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [f]	1.0 [f]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [f]	1.0 [f]	0.1	Ground
Earthquake:					
a. Building 371	1.0	0.001 [g]	0.1 [g]	0.1	Ground
b. Building 707	1.0	0.001 [g]	0.1 [g]	0.1	Ground
Aircraft Crash:					
a. Building 371 [h]	–	–	–	–	–
b. Building 707 [j]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor N/A = not applicable

[a] 1 drum contains the maximum plutonium content level (500 g) (SAIC 1998a).

[b] Building 371, 2 HEPA Banks; Building 707, 0 HEPA Banks.

[c] The wet nuclear criticality is not a viable accident scenario for the No Action Alternative technology assessment.

[d] 3-day supply of feed and 2-day supply of product.

[e] Materials are opened in a glovebox. No room spill is considered.

[f] The product of ARF×RF = 1.0×10^{-6}.

[g] Add 0.000192 to ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).

[h] The aircraft will not penetrate the building.

[j] Consequences enveloped by the earthquake.

Table D–134 Summary of the Accident Analysis Doses at Rocky Flats

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Neutralization Process—Building 371							
Explosion	2.00×10^{-7}	Metal	6.00×10^{-7}	6.80×10^{-8}	0.0084	0.0002	5.00×10^{-7}
Fire (Room)	0.0609	Metal	0.219	0.0219	2,560	60.9	1.71
Fire (Dock)	0.5	Metal	1.80	0.18	21,000	500	14.0
Spill (Glovebox)	1.74×10^{-10}	Metal	5.22×10^{-10}	5.92×10^{-11}	7.31×10^{-6}	1.74×10^{-7}	4.35×10^{-10}

Accident Scenario	Building Source Term (grams)	Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Spill (Dock)	0.0000125	Metal	0.000045	4.50×10^{-6}	0.525	0.0125	0.00035
Earthquake	0.0356	Metal	0.128	0.0128	1,490	35.6	0.996
Desorption and Passivation Process—Building 371							
Explosion	2.00×10^{-7}	Metal	6.00×10^{-7}	6.80×10^{-8}	0.0084	0.0002	5.00×10^{-7}
Fire (Room)	0.0163	Metal	0.0585	0.00585	683	16.3	0.455
Fire (Dock)	0.5	Metal	1.80	0.18	21,000	500	14.0
Spill (Glovebox)	4.64×10^{-11}	Metal	1.39×10^{-10}	1.58×10^{-11}	1.95×10^{-6}	4.64×10^{-8}	1.16×10^{-10}
Spill (Dock)	0.0000125	Metal	0.000045	4.50×10^{-6}	0.525	0.0125	0.00035
Earthquake	0.00949	Metal	0.0342	0.00342	399	9.49	0.266
Repackaging Process—Building 707							
Explosion	0.1	Metal	0.24	0.026	4,200	100	2.80
Fire (Room)	0.233	Metal	0.535	0.0579	9,360	223	6.24
Fire (Dock)	0.5	Metal	1.20	0.13	21,000	500	14.0
Spill (Glovebox)	4.64×10^{-11}	Metal	1.48×10^{-11}	5.57×10^{-12}	6.96×10^{-7}	3.57×10^{-8}	8.22×10^{-12}
Spill (Dock)	0.0000125	Metal	0.00003	3.25×10^{-6}	0.525	0.0125	0.00035
Earthquake	0.130	Metal	0.312	0.0338	5,460	130	3.64

MEI = maximally exposed individual Met = meteorological data

Table D–135 Summary of the Accident Analysis Risks at Rocky Flats in Terms of Latent Cancer Fatalities per Year

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Neutralization Process—Building 371						
Explosion	0.00005	1.50×10^{-14}	1.70×10^{-15}	2.10×10^{-10}	5.00×10^{-12}	1.00×10^{-14}
Fire (Room)	0.0005	5.48×10^{-8}	5.48×10^{-9}	0.000639	0.0000152	3.41×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.80×10^{-9}	1.80×10^{-10}	0.000021	5.00×10^{-7}	1.12×10^{-8}
Spill (Glovebox)	0.8	2.09×10^{-13}	2.37×10^{-14}	2.92×10^{-9}	6.96×10^{-11}	1.39×10^{-13}
Spill (Dock)	0.001	2.25×10^{-11}	2.25×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.000094	6.02×10^{-9}	6.02×10^{-10}	0.0000702	1.67×10^{-6}	3.74×10^{-8}
Desorption and Passivation Process—Building 371						
Explosion	0.00005	1.50×10^{-14}	1.70×10^{-15}	2.10×10^{-10}	5.00×10^{-12}	1.00×10^{-14}
Fire (Room)	0.0005	1.46×10^{-8}	1.46×10^{-9}	0.000171	4.06×10^{-6}	9.10×10^{-8}
Fire (Dock)	2.0×10^{-6}	1.80×10^{-9}	1.80×10^{-10}	0.0000210	5.00×10^{-7}	1.12×10^{-8}
Spill (Glovebox)	0.8	5.57×10^{-14}	6.31×10^{-15}	7.80×10^{-10}	1.86×10^{-11}	3.71×10^{-14}
Spill (Dock)	0.001	2.25×10^{-11}	2.25×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.000094	1.61×10^{-9}	1.61×10^{-10}	0.0000187	4.46×10^{-7}	9.99×10^{-9}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Repackaging Process—Building 707						
Explosion	0.00005	6.00×10^{-9}	6.50×10^{-10}	0.000105	2.50×10^{-6}	5.60×10^{-8}
Fire (Room)	0.0005	1.34×10^{-7}	1.45×10^{-8}	0.00234	0.0000557	1.25×10^{-6}
Fire (Dock)	2.0×10^{-6}	1.20×10^{-9}	1.30×10^{-10}	0.000021	5.00×10^{-7}	1.12×10^{-8}
Spill (Glovebox)	0.8	5.94×10^{-15}	2.23×10^{-15}	2.78×10^{-10}	1.43×10^{-11}	2.82×10^{-15}
Spill (Dock)	0.001	1.50×10^{-11}	1.63×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.0026	4.06×10^{-7}	4.40×10^{-8}	0.00710	0.000169	3.79×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–136 Alternative 1 Accident Risks During Combustible Residue Processing

Combustible Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Neutralization Process – Building 371						
Aqueous - Contaminated	0.15	9.40×10^{-9}	9.40×10^{-10}	0.00011	2.61×10^{-6}	5.85×10^{-8}
Desorption and Passivation Process – Building 371						
Organic - Contaminated	0.39	7.04×10^{-9}	7.04×10^{-10}	0.0000821	1.96×10^{-6}	4.38×10^{-8}
Repackaging Process – Building 707						
Dry	0.023	1.26×10^{-8}	1.36×10^{-9}	0.00022	5.24×10^{-6}	1.17×10^{-7}
Process All Combustible Residue – Buildings 371 and 707						
Sum	0.55	2.89×10^{-8}	2.99×10^{-9}	0.00038	9.76×10^{-6}	2.18×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.3.2 Alternative 2 – Processing without Plutonium Separation

The combustible residues processing technologies considered for this alternative are blend down, catalytic chemical oxidation, and sonic wash. The blend down process, the catalytic chemical oxidation process, and the sonic wash process will be performed at Rocky Flats in Building 371, Room 3701. Building 707 at Rocky Flats is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process.

Similar accidents are applicable to all of these technologies. **Table D–137** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of combustible residue processing technology at Rocky Flats. **Table D–138** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of combustible residues. The risks associated with these processing technologies are summarized in **Table D–139** and **Table D–140**.

Table D–137 Combustible Residue Accident Scenario Parameters at Rocky Flats

Accident Scenario	Frequency (per year)	Combustible Residues	HEPA Banks	Material at Risk (grams)		
				Blend Down Process Building 371 or Building 707	Catalytic Chemical Oxidation Process Building 371	Sonic Wash Process Building 371
Explosion	0.00005	2 drums	0/2 [a]	1,000 g [b]	1,000 g [b]	1,000 g [b]
Nuclear Criticality	0.0001	Solution	–	N/A [c]	1.0×10^{19} fissions	N/A [c]
Fire:						
a. Room	0.0005	5-day supply [b]	2	7,014 g	610 g	837 g feed + 471 g product [e]
b. Loading Dock	2.0×10^{-6}	4 drums	0	2,000 g [b]	2,000 g [b]	2,000 g [b]
Spill:						
a. Room [f]	–	–	–	–	–	–
b. Glovebox	0.8	1 feed prep container	2	83.5 g	2 g	93.4 g
c. Loading Dock	0.001	1 drum	0	500 g [b]	500 g [b]	500 g [b]

Accident Scenario	*Frequency (per year)*	*Combustible Residues*	*HEPA Banks*	*Material at Risk (grams)*		
				Blend Down Process Building 371 or Building 707	*Catalytic Chemical Oxidation Process Building 371*	*Sonic Wash Process Building 371*
Earthquake:						
a. Building 371	0.000094	5-day supply [d]	0	7,014 g	610 g	837 g feed + 471 g product [e]
b. Building 707	0.0026	5-day supply [d]	0	7,014 g	N/A	N/A
Aircraft Crash:						
a. Building 371	0.00004	The aircraft will not penetrate the building wall. Consequences enveloped by the earthquake.	–	–	–	–
b. Building 707	0.00003		–	–	N/A	N/A

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.1	1.0	Ground
b. Building 371	1.0	0.001	0.1	2.0×10^{-6}	Elevated
Nuclear Criticality [c, g]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.0005	1.0	0.1	Ground
b. Loading Dock	1.0	0.0005	1.0	0.5	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [h]	1.0 [h]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [h]	1.0 [h]	0.1	Ground
Earthquake:					
Buildings 371 and 707	1.0	0.001 [j]	0.1 [j]	0.1	Ground
Aircraft Crash:					
a. Building 707 [k]	–	–	–	–	–
b. Building 371 [l]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Building 707, 0 HEPA Banks; Building 371, 2 HEPA Banks.
[b] 1 drum contains the maximum plutonium content level of 500 g (SAIC 1998a).
[c] The wet nuclear criticality is not a viable accident scenario for the blend down, and sonic wash technology assessments.
[d] 3-day supply of feed and 2-day supply of product.
[e] 90% of the product is glass, 10% is powder. The effect of the vitrified product on the accident source term is negligible. The product powder is included with the feed supply accident source term.
[f] Materials are opened in a glovebox. No room spill is considered.
[g] Refer to Table D–28 for the Building 371 catalytic chemical oxidation criticality accident source term.
[h] The product of ARF×RF = 1.0×10^{-6}.
[j] Add 0.000192 to ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).
[k] Consequences enveloped by the earthquake.
[l] The aircraft will not penetrate the building walls.

Table D–138 Summary of the Accident Analysis Doses at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Blend Down Process—Building 371							
Explosion	2.00×10^{-7}	Metal	6.00×10^{-7}	6.80×10^{-8}	0.0084	0.0002	5.00×10^{-7}
Fire (Room)	0.351	Metal	1.26	0.126	14,700	351	9.82
Fire (Dock)	0.5	Metal	1.80	0.18	21,000	500	14.0
Spill (Glovebox)	1.67×10^{-10}	Metal	5.01×10^{-10}	5.68×10^{-11}	7.01×10^{-6}	1.67×10^{-7}	4.18×10^{-10}
Spill (Dock)	0.0000125	Metal	0.000045	4.50×10^{-6}	0.525	0.0125	0.00035
Earthquake	0.205	Metal	0.737	0.0737	8,600	205	5.73

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Blend Down Process—Building 707							
Explosion	0.100	Metal	0.240	0.0260	4,200	100	2.80
Fire (Room)	0.351	Metal	0.842	0.0912	14,700	351	9.82
Fire (Dock)	0.500	Metal	1.20	0.130	21,000	5.00	14.0
Spill (Glovebox)	1.67×10^{-10}	Metal	5.34×10^{-11}	2.00×10^{-11}	2.51×10^{-6}	1.29×10^{-7}	3.17×10^{-11}
Spill (Dock)	0.0000125	Metal	0.0000300	3.25×10^{-6}	0.525	0.0125	0.000350
Earthquake	0.205	Metal	0.492	0.0533	8,600	205	5.73
Catalytic Chemical Oxidation Process—Building 371							
Explosion	2.00×10^{-7}	Metal	6.00×10^{-7}	6.80×10^{-8}	0.0084	0.0002	5.00×10^{-7}
Nuclear Criticality	[a]	–	0.79	0.11	0.00698	252	0.321
Fire (Room)	0.0305	Metal	0.11	0.011	1,280	30.5	0.854
Fire (Dock)	0.5	Metal	1.80	0.18	21,000	500	14.0
Spill (Glovebox)	4.00×10^{-12}	Metal	1.20×10^{-11}	1.36×10^{-12}	1.68×10^{-7}	4.00×10^{-9}	1.00×10^{-11}
Spill (Dock)	0.0000125	Metal	0.000045	4.50×10^{-6}	0.525	0.0125	0.00035
Earthquake	0.0178	Metal	0.0641	0.00641	748	17.8	0.499
Sonic Wash Process—Building 371							
Explosion	2.00×10^{-7}	Metal	6.00×10^{-7}	6.80×10^{-8}	0.0084	0.0002	5.00×10^{-7}
Fire (Room)	0.0419	Metal	0.151	0.0151	1,760	41.9	1.17
Fire (Dock)	0.5	Metal	1.80	0.18	21,000	500	14.0
Spill (Glovebox)	1.87×10^{-10}	Metal	5.60×10^{-10}	6.35×10^{-11}	7.85×10^{-6}	1.87×10^{-7}	4.67×10^{-10}
Spill (Dock)	0.0000125	Metal	0.000045	4.50×10^{-6}	0.525	0.0125	0.00035
Earthquake	0.0244	Metal	0.088	0.0088	1,030	24.4	0.684

MEI = maximally exposed individual Met = meteorological data

[a] 1.0×10^{19} fissions.

Table D–139 Summary of the Accident Analysis Risks at Rocky Flats in Terms of Latent Cancer Fatalities per Year

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Blend Down Process—Building 371						
Explosion	0.00005	1.50×10^{-14}	1.70×10^{-15}	2.10×10^{-10}	5.00×10^{-12}	1.00×10^{-14}
Fire (Room)	0.0005	3.16×10^{-7}	3.16×10^{-8}	0.00368	0.0000877	1.96×10^{-6}
Fire (Dock)	2.0×10^{-6}	1.80×10^{-9}	1.80×10^{-10}	0.000021	5.00×10^{-7}	1.12×10^{-8}
Spill (Glovebox)	0.8	2.00×10^{-13}	2.27×10^{-14}	2.81×10^{-9}	6.68×10^{-11}	1.34×10^{-13}
Spill (Dock)	0.001	2.25×10^{-11}	2.25×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.000094	3.47×10^{-8}	3.47×10^{-9}	0.000404	9.63×10^{-6}	2.16×10^{-7}

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Blend Down Process—Building 707						
Explosion	0.00005	6.00×10^{-9}	6.50×10^{-10}	0.000105	2.50×10^{-6}	5.60×10^{-8}
Fire (Room)	0.0005	2.10×10^{-6}	2.28×10^{-8}	0.00368	0.0000877	1.96×10^{-6}
Fire (Dock)	2.0×10^{-6}	1.20×10^{-9}	1.30×10^{-10}	0.0000210	5.00×10^{-7}	1.12×10^{-8}
Spill (Glovebox)	0.8	2.14×10^{-14}	8.02×10^{-15}	1.00×10^{-9}	5.14×10^{-11}	1.02×10^{-14}
Spill (Dock)	0.001	1.50×10^{-11}	1.63×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.0026	6.39×10^{-7}	6.92×10^{-8}	0.0112	0.000226	5.96×10^{-6}
Catalytic Chemical Oxidation Process—Building 371						
Explosion	0.00005	1.50×10^{-14}	1.70×10^{-15}	2.10×10^{-10}	5.00×10^{-12}	1.00×10^{-14}
Nuclear Criticality	0.0001	3.95×10^{-8}	5.50×10^{-9}	3.49×10^{-10}	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	2.75×10^{-8}	2.75×10^{-9}	0.00032	7.63×10^{-6}	1.71×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.80×10^{-9}	1.80×10^{-10}	0.000021	5.00×10^{-7}	1.12×10^{-8}
Spill (Glovebox)	0.8	4.80×10^{-15}	5.44×10^{-16}	6.72×10^{-11}	1.60×10^{-12}	3.20×10^{-15}
Spill (Dock)	0.001	2.25×10^{-11}	2.25×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.000094	3.01×10^{-9}	3.01×10^{-10}	0.0000352	8.37×10^{-7}	1.88×10^{-8}
Sonic Wash Process—Building 371						
Explosion	0.00005	1.50×10^{-14}	1.70×10^{-15}	2.10×10^{-10}	5.00×10^{-12}	1.00×10^{-14}
Fire (Room)	0.0005	3.77×10^{-8}	3.77×10^{-9}	0.000439	0.0000105	2.34×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.80×10^{-9}	1.80×10^{-10}	0.000021	5.00×10^{-7}	1.12×10^{-8}
Spill (Glovebox)	0.8	2.24×10^{-13}	2.54×10^{-14}	3.14×10^{-9}	7.47×10^{-11}	1.49×10^{-13}
Spill (Dock)	0.001	2.25×10^{-11}	2.25×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.000094	4.14×10^{-9}	4.14×10^{-10}	0.0000482	1.15×10^{-6}	2.57×10^{-8}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–140 Alternative 2 Accident Risks During Combustible Residue Processing

Combustible Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Blend Down Process – Building 371						
Aqueous - Contaminated	0.026	9.15×10^{-9}	9.15×10^{-10}	0.000107	2.54×10^{-6}	5.70×10^{-8}
Organic - Contaminated	0.018	6.34×10^{-9}	6.34×10^{-10}	0.0000739	1.76×10^{-6}	3.94×10^{-8}
Dry	0.015	5.28×10^{-9}	5.28×10^{-10}	0.0000616	1.47×10^{-6}	3.29×10^{-8}

Combustible Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
All Combustible Residue	0.059	2.08×10^{-8}	2.08×10^{-9}	0.000242	5.77×10^{-6}	1.29×10^{-7}
Blend Down Process – Building 707						
Aqueous - Contaminated	0.026	2.23×10^{-8}	2.41×10^{-9}	0.00039	9.28×10^{-6}	2.08×10^{-7}
Organic - Contaminated	0.018	1.54×10^{-8}	1.67×10^{-9}	0.00027	6.42×10^{-6}	1.44×10^{-7}
Dry	0.015	1.28×10^{-8}	1.39×10^{-9}	0.000225	5.35×10^{-6}	1.20×10^{-7}
All Combustible Residues	0.059	5.05×10^{-8}	5.48×10^{-9}	0.000884	0.0000211^{-11}	4.72×10^{-7}
Catalytic Chemical Oxidation Process – Building 371						
Aqueous - Contaminated	0.45	3.23×10^{-8}	3.93×10^{-9}	0.00017	9.71×10^{-6}	9.62×10^{-8}
Organic - Contaminated	0.32	2.30×10^{-8}	2.79×10^{-9}	0.000121	6.90×10^{-6}	6.84×10^{-8}
Dry	0.26	1.87×10^{-8}	2.27×10^{-9}	0.0000979	5.61×10^{-6}	5.56×10^{-8}
All Combustible Residues	1.03	7.39×10^{-8}	8.99×10^{-9}	0.000388	0.0000222	2.20×10^{-7}
Sonic Wash Process – Building 371						
Aqueous - Contaminated	0.14	6.11×10^{-9}	6.11×10^{-10}	0.0000713	1.70×10^{-6}	3.80×10^{-8}
Organic - Contaminated	0.09	3.93×10^{-9}	3.93×10^{-10}	0.0000458	1.09×10^{-6}	2.44×10^{-8}
Dry	0.08	3.49×10^{-9}	3.49×10^{-10}	0.0000407	9.69×10^{-7}	2.17×10^{-8}
All Combustible Residues	0.31	1.35×10^{-8}	1.35×10^{-9}	0.000158	3.76×10^{-6}	8.41×10^{-8}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.3.3 Alternative 3 – Processing with Plutonium Separation

The combustible residues processing technology considered for this alternative is mediated electrochemical oxidation. Most of the mediated electrochemical oxidation process will be performed at Rocky Flats in Building 371, Room 3701. The final calcination in the process will be performed at Rocky Flats in Building 707A, Module J.

Similar accidents are applicable to the mediated electrochemical oxidation processes in both buildings. **Table D–141** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of processing combustible residues using the mediated electrochemical oxidation technology at Rocky Flats. **Table D–142** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of combustible residues. The risks associated with this processing technology are summarized in **Table D–143** and **Table D–144**.

Table D–141 Combustible Residue Accident Scenario Parameters at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Combustible Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				MEO Process	
				Building 371	*Building 707A* [a]
Explosion (Acetylene)	0.00005	2 drums	2/0 [b]	1,000 g [c]	4,000 g
Explosion (Ion Exchange Column)	0.0001	Solution	2	0.245 mg [d]	N/A
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	N/A [e]
Fire:					
a. Room	0.0005	5-day supply [f]	2	2,626 g	3,000 g
b. Loading Dock	2.0×10^{-6}	4 drums	0	2,000 g [c]	4,000 g
Spill:					
a. Room [g]	–	–	–	–	–
b. Glovebox	0.8	1 feed prep container	2	93.8 g	1,000 g
c. Loading Dock	0.001	1 drum	0	500 g[c]	3,000 g
Earthquake:					
a. Building 371	0.000094	5-day supply [f]	0	2,626 g	N/A
b. Building 707A	0.0026	5-day supply [f]	0	N/A	3,000 g
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall. Consequences enveloped by the earthquake.	–	–	N/A
b. Building 707A	0.00001		–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion (Acetylene):					
a. Building 707A	1.0	0.001	0.1	1.0	Ground
b. Building 371	1.0	0.001	0.1	2.0×10^{-6}	Elevated
Explosion (Ion Exchange Column) [d]	1.0	1.0	1.0	1.0	Elevated
Nuclear Criticality [e, h]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.0005	1.0	0.1	Ground
b. Loading Dock	1.0	0.0005	1.0	0.5	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [j]	1.0 [j]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [j]	1.0 [j]	0.1	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.001 [k]	0.1 [k]	0.1	Ground
Aircraft Crash:					
a. Building 707A [l]	–	–	–	–	–
b. Building 371 [m]	–	–	–	–	–

MEO = mediated electrochemical oxidation N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1,000-g product drums are transported from Building 371 to Building 707A for processing.

[b] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.1.0×10^{-6}.

[c] 1 drum contains the maximum plutonium content level (500 g) (SAIC 1998a).

[d] Respirable source term value in milligrams of plutonium released up the stack.

[e] The wet nuclear criticality is not a viable accident scenario for the mediated electrochemical oxidation process in Building 707A.

[f] 3-day supply of feed and 2-day supply of product.
[g] Materials are opened in a glovebox. No room spill is considered.
[h] Refer to Table D–28 for Building 371 mediated electrochemical oxidation criticality accident source term.
[j] The product of ARF×RF = 1.0×10^{-6}.
[k] Add 0.000192 to ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).
[l] Consequences enveloped by the earthquake.
[m] The aircraft will not penetrate the building walls.

Table D–142 Summary of the Accident Analysis Doses at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371							
Explosion (Acetylene)	2.00×10^{-7}	Metal	6.00×10^{-7}	6.80×10^{-8}	0.0084	0.0002	5.00×10^{-7}
Explosion (Ion Exchange Column)	0.000245	Metal	0.000735	0.0000833	10.3	0.245	0.000613
Criticality (Liquid)	[a]	–	0.79	0.11	6,980	25.2	0.321
Fire (Room)	0.131	Metal	0.473	0.0473	5,510	131	3.68
Fire (Dock)	0.5	Metal	1.80	0.18	21,000	500	14.0
Spill (Glovebox)	1.88×10^{-10}	Metal	5.63×10^{-10}	6.38×10^{-11}	7.88×10^{-6}	1.88×10^{-7}	4.69×10^{-10}
Spill (Dock)	0.0000125	Metal	0.000045	4.50×10^{-6}	0.525	0.0125	0.00035
Earthquake	0.0767	Metal	0.276	0.0276	3,220	76.7	2.15
Building 707A							
Explosion (Acetylene)	0.4	Oxide	0.48	0.052	10,000	240	8.40
Fire (Room)	0.15	Oxide	0.18	0.0195	3,750	90.0	3.15
Fire (Dock)	1.00	Oxide	1.20	0.13	25,000	600	21.0
Spill (Glovebox)	2.00×10^{-9}	Oxide	3.20×10^{-10}	1.20×10^{-10}	0.0000174	9.00×10^{-7}	2.80×10^{-10}
Spill (Dock)	0.000075	Oxide	0.00009	9.75×10^{-6}	1.88	0.045	0.00158
Earthquake	0.0876	Oxide	0.15	0.0114	2,190	52.6	1.84

MEI = maximally exposed individual Met = meteorological data
[a] 1.0×10^{19} fissions.

Table D–143 Summary of the Accident Analysis Risks at Rocky Flats in Terms of Latent Cancer Fatalities per Year

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371						
Explosion (Acetylene)	0.00005	1.50×10^{-14}	1.70×10^{-15}	2.10×10^{-10}	5.00×10^{-12}	1.00×10^{-14}
Explosion (Ion Exchange Column)	0.0001	3.68×10^{-11}	4.17×10^{-12}	5.15×10^{-7}	1.23×10^{-9}	2.45×10^{-11}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	1.26×10^{-6}	1.28×10^{-8}
Fire (Room)	0.0005	1.18×10^{-7}	1.18×10^{-8}	0.00138	0.0000328	7.35×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.80×10^{-9}	1.80×10^{-10}	0.000021	5.00×10^{-7}	1.12×10^{-8}

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Spill (Glovebox)	0.8	2.25×10^{-13}	2.55×10^{-14}	3.15×10^{-9}	7.50×10^{-11}	1.50×10^{-13}
Spill (Dock)	0.001	2.25×10^{-11}	2.25×10^{-12}	2.63×10^{-7}	6.25×10^{-9}	1.40×10^{-10}
Earthquake	0.000094	1.30×10^{-8}	1.30×10^{-9}	0.000151	3.60×10^{-6}	8.07×10^{-8}
Building 707A						
Explosion (Acetylene)	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.00025	6.00×10^{-6}	1.68×10^{-7}
Fire (Room)	0.0005	4.50×10^{-8}	4.88×10^{-9}	0.000938	0.0000225	6.30×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.20×10^{-9}	1.30×10^{-10}	0.0000250	6.00×10^{-7}	3.36×10^{-8}
Spill (Glovebox)	0.8	1.28×10^{-13}	4.80×10^{-14}	6.96×10^{-9}	3.60×10^{-10}	8.96×10^{-14}
Spill (Dock)	0.001	4.50×10^{-11}	4.88×10^{-12}	9.38×10^{-7}	2.25×10^{-8}	6.30×10^{-10}
Earthquake	0.0026	1.37×10^{-7}	1.48×10^{-8}	0.00285	0.0000683	1.91×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–144 Alternative 3 Accident Risks During the Mediated Electrochemical Oxidation Process at Rocky Flats

Combustible Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
Aqueous - Contaminated	0.07	1.21×10^{-8}	1.32×10^{-9}	0.000133	2.67×10^{-6}	5.88×10^{-8}
Organic - Contaminated	0.05	8.63×10^{-9}	9.40×10^{-10}	0.000095	1.91×10^{-6}	4.20×10^{-8}
Dry	0.04	6.90×10^{-9}	7.52×10^{-10}	0.000076	1.53×10^{-6}	3.36×10^{-8}
All Combustible Residues	0.16	2.76×10^{-8}	3.01×10^{-9}	0.000304	6.11×10^{-6}	1.34×10^{-7}
Building 707A						
Aqueous - Contaminated	0.06	1.17×10^{-8}	1.27×10^{-9}	0.000244	5.85×10^{-6}	1.65×10^{-7}
Organic - Contaminated	0.04	7.80×10^{-9}	8.45×10^{-10}	0.000162	3.90×10^{-6}	1.10×10^{-7}
Dry	0.03	5.85×10^{-9}	6.33×10^{-10}	0.000122	2.92×10^{-6}	8.24×10^{-8}
All Combustible Residues	0.13	2.53×10^{-8}	2.74×10^{-9}	0.000528	0.0000127	3.57×10^{-7}
Buildings 371 and 707A						
Aqueous - Contaminated	–	2.38×10^{-8}	2.59×10^{-9}	0.000377	8.52×10^{-6}	2.24×10^{-7}
Organic - Contaminated	–	1.64×10^{-8}	1.79×10^{-9}	0.000257	5.81×10^{-6}	1.52×10^{-7}
Dry	–	1.28×10^{-8}	1.39×10^{-9}	0.000198	4.45×10^{-6}	1.16×10^{-7}
All Combustible Residues	–	5.29×10^{-8}	5.75×10^{-9}	0.000832	0.0000188	4.91×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

[a] Sum of postulated accident scenario risks

D.3.4.3.4 Alternative 4 – Combination of Processing Technologies

Combustible residue processing technologies considered for this alternative are the neutralization/dry process for the aqueous-contaminated residue, the thermal desorption/steam passivation process for the organic-contaminated residue, and the repackaging process for the dry residue. The process technology accident descriptions, consequences and risks are identical to those presented in Section D.3.4.3.1, Alternative 1 - No Action. Refer to Section D.3.4.3.1 for details.

D.3.4.4 Fluoride Residues

D.3.4.4.1 Alternative 1 – No Action

The fluoride residues processing technology considered for this alternative is the acid dissolution/plutonium oxide recovery process. Most of the acid dissolution/plutonium oxide recovery process will be performed at Rocky Flats in Building 371, Room 3701. The final calcination will be performed at Rocky Flats in Building 707A, Module J.

Similar accidents are applicable to both buildings. **Table D–145** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of using the acid dissolution/plutonium oxide recovery process. **Table D–146** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with this processing technology at Rocky Flats. The risks associated with this processing technology at Rocky Flats are summarized in **Table D–147** and **Table D–148**.

Table D–145 Fluoride Residue Accident Scenario Parameters for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Fluoride Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Acid Dissolution/Plutonium Oxide Recovery Process	
				Building 371	*Building 707A* [a]
Explosion	0.00005	2 drums	2/0 [b]	4,000 g [c]	2,000 g
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	N/A [d]
Fire:					
a. Room	0.0005	5-day supply [e]	2	5,600 g	8,000 g
b. Loading Dock	2.0×10^{-6}	4 drums	0	6,000 g [f]	4,000 g
Spill:					
a. Room	0.008	1 container at the maximum limit [g]	2	3,000 g	N/A [g]
b. Glovebox	0.8	1 feed prep container	2	200 g	1,000 g
c. Loading Dock	0.001	1 drum	0	3,000 g [h]	1,000 g
Earthquake:					
a. Building 371	0.000094	5-day supply [e]	0	5,600 g	N/A
b. Building 707A	0.0026	5-day supply [e]	0	N/A	8,000 g

Accident Scenario	*Frequency (per year)*	*Fluoride Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Acid Dissolution/Plutonium Oxide Recovery Process	
				Building 371	*Building 707A* [a]
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707A	1.0	0.001	0.01	1.0	Ground
b. Building 371	1.0	0.001	0.01	2.0×10^{-6}	Elevated
Nuclear Criticality [d, j]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.001	0.001	0.1	Ground
b. Loading Dock	0.01	0.001	0.001	0.5	Ground
Spill:					
a. Room [k]	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.5	0.1	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.002 [l]	0.3 [l]	0.1	Ground
Aircraft Crash:					
a. Building 707A [m]	–	–	–	–	–
b. Building 371 [n]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction
LPF = leak path factor

[a] 1,000-g product drums are transported from Building 371 to Building 707A for processing (1 drum per batch).
[b] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.
[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.
[d] The wet nuclear criticality is not a viable accident scenario for the process in Building 707A.
[e] 3-day supply of feed and 2-day supply of product.
[f] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[g] 1 container per drum of feed.
[h] 1 drum at the maximum plutonium content level.
[j] Refer to Table D–28 for Building 371 criticality accident source term.
[k] Materials are opened in a glovebox in Building 707A. No room spill is considered.
[l] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[m] Consequences enveloped by the earthquake.
[n] The aircraft will not penetrate the building walls.

Table D–146 Summary of the Accident Analysis Doses for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Building 371							
Explosion	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.00008	2.00×10^{-7}
Criticality (Liquid)	[a]	–	0.79	0.11	6,980	252	0.321
Fire (Room)	0.00056	Metal	0.00202	0.000202	23.5	0.56	0.0157
Fire (Dock)	0.00003	Metal	0.000108	0.0000108	1.26	0.03	0.00084
Spill (Room)	1.20×10^{-9}	Metal	3.60×10^{-9}	4.08×10^{-10}	0.0000504	1.20×10^{-6}	3.00×10^{-9}
Spill (Glovebox)	8.00×10^{-11}	Metal	2.40×10^{-10}	2.72×10^{-11}	3.36×10^{-6}	8.00×10^{-8}	2.00×10^{-10}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	0.444	Metal	1.60	0.16	18,600	444	12.4
Building 707A							
Explosion	0.02	Oxide	0.024	0.0026	500	12.0	0.42
Fire (Room)	0.0008	Oxide	0.00096	0.000104	0.200	0.48	0.0168
Fire (Dock)	0.00002	Oxide	0.000024	2.60×10^{-6}	0.500	0.012	0.00042
Spill (Glovebox)	4.00×10^{-10}	Oxide	6.40×10^{-11}	2.40×10^{-11}	3.48×10^{-6}	1.80×10^{-7}	5.60×10^{-11}
Spill (Dock)	0.001	Oxide	0.0012	0.00013	25.0	0.6	0.021
Earthquake	0.634	Oxide	0.76	0.0824	15,800	380	13.3

MEI = maximally exposed individual Met = meteorological data

[a] 1.0×10^{19} fissions.

Table D–147 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Building 371						
Explosion	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	5.04×10^{-10}	5.04×10^{-11}	5.88×10^{-6}	1.40×10^{-7}	3.14×10^{-9}
Fire (Dock)	2.0×10^{-6}	1.08×10^{-13}	1.08×10^{-14}	1.26×10^{-9}	3.00×10^{-11}	6.72×10^{-13}
Spill (Room)	0.008	1.44×10^{-14}	1.63×10^{-15}	2.02×10^{-10}	4.80×10^{-12}	9.60×10^{-15}
Spill (Glovebox)	0.8	9.60×10^{-14}	1.09×10^{-14}	1.34×10^{-9}	3.20×10^{-11}	6.40×10^{-14}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	7.50×10^{-8}	7.50×10^{-9}	0.000876	0.0000208	4.67×10^{-7}
Building 707A						
Explosion	0.00005	6.00×10^{-10}	6.50×10^{-11}	0.0000125	3.00×10^{-7}	8.40×10^{-9}
Fire (Room)	0.0005	2.40×10^{-10}	2.60×10^{-11}	5.00×10^{-6}	1.20×10^{-7}	3.36×10^{-9}
Fire (Dock)	2.0×10^{-6}	2.40×10^{-14}	2.60×10^{-15}	5.00×10^{-10}	1.20×10^{-11}	3.36×10^{-13}
Spill (Glovebox)	0.8	2.56×10^{-14}	9.60×10^{-15}	1.39×10^{-9}	7.20×10^{-11}	1.79×10^{-14}
Spill (Dock)	0.001	6.00×10^{-10}	6.50×10^{-11}	0.0000125	3.00×10^{-7}	8.40×10^{-9}
Earthquake	0.0026	9.88×10^{-7}	1.07×10^{-7}	0.0206	0.000494	0.0000138

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–148 Alternative 1 Accident Risks During Fluoride Residue Processing

Fluoride Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
All Residues	0.49	5.90×10^{-8}	6.66×10^{-9}	0.000634	0.0000172	2.53×10^{-7}
Building 707A						
All Residues	0.34	3.37×10^{-7}	3.65×10^{-8}	0.00701	0.000168	4.71×10^{-6}
Buildings 371 and 707A						
All Residues	0.83	3.96×10^{-7}	4.31×10^{-8}	0.00765	0.000185	4.96×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.4.2 Alternative 2 – Processing without Plutonium Separation

The fluoride residues processing technology considered for this alternative is blending down. The blend down process will be performed at Rocky Flats in Building 707, Module E. Building 371 is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process. **Table D–149** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of fluoride processing technology at Rocky Flats. **Table D–150** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of fluoride residues. The risks associated with this processing technology are summarized in **Table D–151** and **Table D–152**.

Table D–149 Fluoride Residue Accident Scenario Parameters for the Blend Down Process at Rocky Flats

Accident Scenario	Frequency (per year)	Fluoride Residues	HEPA Banks	Material at Risk (grams)
Explosion	0.00005	2 drums [a]	0/2 [b]	4,000 g
Nuclear Criticality [c]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [d]	2	1,738 g
b. Loading Dock	2.0×10^{-6}	4 drums [e]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the limit [f]	2	600 g
b. Glovebox	0.8	1 feed prep container	2	18.1 g
c. Loading Dock	0.001	1 drum [g]	0	3,000 g
Earthquake:				
a. Building 707	0.0026	5-day supply [d]	0	1,738 g
b. Building 371	0.000094	5-day supply [d]	0	1,738 g
Aircraft Crash:				
a. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–
b. Building 371	0.00004	The aircraft will not penetrate the building walls.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.01	1.0	Ground
b. Building 371	1.0	0.001	0.01	2.0×10^{-6}	Elevated
Nuclear Criticality [c]	–	–	–	–	–
Fire:					
a. Room	1.0	0.001	0.001	0.1	Ground
b. Loading Dock	0.01	0.001	0.001	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.5	0.1	Ground
Earthquake	1.0	0.002 [h]	0.3 [h]	0.10	Ground
Aircraft Crash					
a. Building 707 [j]	–	–	–	–	–
b. Building 371 [k]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] Building 371, 2 HEPA Banks; Building 707, 0 HEPA Banks.

[c] The wet nuclear criticality is not a viable accident scenario for the blend down technology assessment.

[d] 3-day supply of feed and 2-day supply of product.

[e] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[f] 5 containers per drum of feed.

[g] 1 drum at the maximum plutonium content level.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[j] Enveloped by the earthquake.

[k] The aircraft will not penetrate the building walls.

Table D–150 Summary of the Accident Analysis Doses for the Blend Down Process at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 707							
Explosion	0.04	Metal	0.096	0.0104	1,680	40.0	1.12
Fire (Room)	0.000174	Metal	0.000417	0.0000452	7.30	0.174	0.00487
Fire (Dock)	0.00003	Metal	0.000072	7.80×10^{-6}	1.26	0.03	0.00084
Spill (Room)	2.40×10^{-10}	Metal	7.68×10^{-11}	2.88×10^{-11}	3.60×10^{-6}	1.85×10^{-7}	4.56×10^{-11}
Spill (Glovebox)	7.24×10^{-12}	Metal	2.32×10^{-12}	8.69×10^{-13}	1.09×10^{-7}	5.57×10^{-9}	1.38×10^{-12}
Spill (Dock)	0.003	Metal	0.0072	0.00078	126	3.00	0.084
Earthquake	0.138	Metal	0.330	0.0358	5,780	138	3.85
Building 371							
Explosion	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.0000800	2.00×10^{-7}
Fire (Room)	0.000174	Metal	0.000626	0.0000626	7.30	0.174	0.00487
Fire (Dock)	0.0000300	Metal	0.000108	0.0000108	1.26	0.0300	0.000840
Spill (Room)	2.40×10^{-10}	Metal	7.20×10^{-10}	8.16×10^{-11}	0.0000101	2.40×10^{-7}	6.00×10^{-10}
Spill (Glovebox)	7.24×10^{-12}	Metal	2.17×10^{-11}	2.46×10^{-12}	3.04×10^{-7}	7.24×10^{-9}	1.81×10^{-11}
Spill (Dock)	0.00300	Metal	0.0108	0.00108	126	3.00	0.0840
Earthquake	0.138	Metal	0.496	0.0496	5,780	138	3.85

MEI = maximally exposed individual Met = meteorological data

Table D–151 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Blend Down Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 707						
Explosion	0.00005	2.40×10^{-9}	2.60×10^{-10}	0.000042	1.00×10^{-6}	2.24×10^{-8}
Fire (Room)	0.0005	1.04×10^{-10}	1.13×10^{-11}	1.82×10^{-6}	4.35×10^{-8}	9.73×10^{-10}
Fire (Dock)	2.0×10^{-6}	7.20×10^{-14}	7.80×10^{-15}	1.26×10^{-9}	3.00×10^{-11}	6.72×10^{-13}
Spill (Room)	0.008	3.07×10^{-16}	1.15×10^{-16}	1.44×10^{-11}	7.39×10^{-13}	1.46×10^{-16}
Spill (Glovebox)	0.80	9.27×10^{-16}	3.48×10^{-16}	4.34×10^{-11}	2.23×10^{-12}	4.40×10^{-16}
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	4.29×10^{-7}	4.65×10^{-8}	0.00752	0.000179	4.01×10^{-6}
Building 371						
Explosion	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Fire (Room)	0.0005	1.56×10^{-10}	1.56×10^{-11}	1.82×10^{-6}	4.35×10^{-8}	9.73×10^{-10}
Fire (Dock)	2.0×10^{-6}	1.08×10^{-13}	1.08×10^{-14}	1.26×10^{-9}	3.00×10^{-11}	6.72×10^{-13}
Spill (Room)	0.008	2.88×10^{-15}	3.26×10^{-16}	4.03×10^{-11}	9.60×10^{-13}	1.92×10^{-15}
Spill (Glovebox)	0.8	8.69×10^{-15}	9.85×10^{-16}	1.22×10^{-10}	2.90×10^{-12}	5.79×10^{-15}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.0000630	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	2.33×10^{-8}	2.33×10^{-9}	0.000272	6.47×10^{-6}	1.45×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–152 Alternative 2 Accident Risks During Fluoride Residue Processing

Fluoride Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 707						
All Residues	1.57	6.84×10^{-7}	7.41×10^{-8}	0.012	0.000285	6.38×10^{-6}
Building 371						
All Residues	1.57	4.53×10^{-8}	4.53×10^{-9}	0.000528	0.0000126	2.82×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.4.3 Alternative 3 – Processing with Plutonium Separation

The fluoride residues processing technologies considered for this alternative are the acid dissolution/plutonium oxide recovery process performed at Rocky Flats and the Purex/plutonium metal (or oxide) recovery process performed at the Savannah River Site. At Rocky Flats, most of the acid dissolution/plutonium oxide recovery process will be performed in Building 371, Room 3701. The final calcination will be performed in Building 707A, Module J. For processing at the Savannah River Site, the packaging of the fluoride residues at Rocky Flats will be performed in Building 371, Room 3701. The Purex/plutonium metal (or oxide) recovery process will be performed in canyon facilities at the Savannah River Site.

Similar accidents are applicable to both processing technologies. **Table D–153** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of the acid dissolution/plutonium oxide recovery processing technology at Rocky Flats. **Table D–154** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with this processing technology at Rocky Flats. The risks associated with this processing technology at Rocky Flats are summarized in **Table D–155** and **Table D–156**.

Table D–153 Fluoride Residue Accident Scenario Parameters for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Fluoride Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Acid Dissolution/Plutonium Oxide Recovery Process	
				Building 371	*Building 707A* [a]
Explosion	0.00005	2 drums	2/0 [b]	4,000 g [c]	2,000 g
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	N/A [d]
Fire:					
a. Room	0.0005	5-day supply [e]	2	5,600 g	8,000 g
b. Loading Dock	2.0×10^{-6}	4 drums	0	6,000 g [f]	4,000 g
Spill:					
a. Room	0.008	1 container at the maximum limit [g]	2	3,000 g	N/A [h]
b. Glovebox	0.80	1 feed prep container	2	200 g	1,000 g
c. Loading Dock	0.001	1 drum	0	3,000 g [j]	1,000 g
Earthquake:					
a. Building 371	0.000094	5-day supply [e]	0	5,600 g	N/A
b. Building 707A	0.0026	5-day supply [e]	0	N/A	8,000 g
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707A	1.0	0.001	0.01	1.0	Ground
b. Building 371	1.0	0.001	0.01	2.0×10^{-6}	Elevated
Nuclear Criticality [d, k]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.001	0.001	0.10	Ground
b. Loading Dock	0.01	0.001	0.001	0.50	Ground
Spill:					
a. Room [h]	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.002 [l]	0.30 [l]	0.10	Ground
Aircraft Crash:					
a. Building 707A [m]	–	–	–	–	–
b. Building 371 [n]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1,000-g product drums are transported from Building 371 to Building 707A for processing.
[b] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.
[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.
[d] The wet nuclear criticality is not a viable accident scenario for the process in Building 707A.
[e] 3-day supply of feed and 2-day supply of product.
[f] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[g] 1 container per drum of feed.
[h] Materials are opened in a glovebox in Building 707A. No room spill is considered.
[j] 1 drum at the maximum plutonium content level.
[k] Refer to Table D–28 for Building 371 criticality accident source term.
[l] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[m] Consequences enveloped by the earthquake.
[n] The aircraft will not penetrate the building walls.

Table D–154 Summary of the Accident Analysis Doses for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	*Building Source Term (grams)*	*Type*	*MEI (rem) 95% Met*	*MEI (rem) 50% Met*	*Population (person-rem) 95% Met*	*Population (person-rem) 50% Met*	*Worker (rem) 50% Met*
Building 371							
Explosion	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.00008	2.00×10^{-7}
Criticality (Liquid)	[a]	–	0.790	0.110	6,980	252	0.321
Fire (Room)	0.00056	Metal	0.00202	0.000202	23.5	0.560	0.0157
Fire (Dock)	0.00003	Metal	0.000108	0.0000108	1.26	0.03	0.00084
Spill (Room)	1.20×10^{-9}	Metal	3.60×10^{-9}	4.08×10^{-10}	0.0000504	1.20×10^{-6}	3.00×10^{-9}
Spill (Glovebox)	8.00×10^{-11}	Metal	2.40×10^{-10}	2.72×10^{-11}	3.36×10^{-6}	8.00×10^{-8}	2.00×10^{-10}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	0.444	Metal	1.60	0.160	18,600	444	12.4
Building 707A							
Explosion	0.02	Oxide	0.024	0.0026	500	12.0	0.420
Fire (Room)	0.0008	Oxide	0.00096	0.000104	20.0	0.480	0.0168
Fire (Dock)	0.00002	Oxide	0.000024	2.60×10^{-6}	0.500	0.012	0.00042
Spill (Glovebox)	4.00×10^{-10}	Oxide	6.40×10^{-11}	2.40×10^{-11}	3.48×10^{-6}	1.80×10^{-7}	5.60×10^{-11}
Spill (Dock)	0.001	Oxide	0.0012	0.00013	25.0	0.600	0.021
Earthquake	0.634	Oxide	0.760	0.0824	15,800	380	13.3

MEI = maximally exposed individual Met = meteorological data
[a] 1.0×10^{19} fissions.

Table D–155 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
Explosion	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	5.04×10^{-10}	5.04×10^{-11}	5.88×10^{-6}	1.40×10^{-7}	3.14×10^{-9}
Fire (Dock)	2.0×10^{-6}	1.08×10^{-13}	1.08×10^{-14}	1.26×10^{-9}	3.00×10^{-11}	6.72×10^{-13}
Spill (Room)	0.008	1.44×10^{-14}	1.63×10^{-15}	2.02×10^{-10}	4.80×10^{-12}	9.60×10^{-15}
Spill (Glovebox)	0.80	9.60×10^{-14}	1.09×10^{-14}	1.34×10^{-9}	3.20×10^{-11}	6.40×10^{-14}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	7.50×10^{-8}	7.50×10^{-9}	0.000876	0.0000208	4.67×10^{-7}
Building 707A						
Explosion	0.00005	6.00×10^{-10}	6.50×10^{-11}	0.0000125	3.00×10^{-7}	8.40×10^{-9}
Fire (Room)	0.0005	2.40×10^{-10}	2.60×10^{-11}	5.00×10^{-6}	1.20×10^{-7}	3.36×10^{-9}
Fire (Dock)	2.0×10^{-6}	2.40×10^{-14}	2.60×10^{-15}	5.00×10^{-10}	1.20×10^{-11}	3.36×10^{-13}
Spill (Glovebox)	0.80	2.56×10^{-14}	9.60×10^{-15}	1.39×10^{-9}	7.20×10^{-11}	1.79×10^{-14}
Spill (Dock)	0.001	6.00×10^{-10}	6.50×10^{-11}	0.0000125	3.00×10^{-7}	8.40×10^{-9}
Earthquake	0.0026	9.88×10^{-7}	1.07×10^{-7}	0.0206	0.000494	0.0000138

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–156 Alternative 3 Accident Risks During the Acid Dissolution/Plutonium Oxide Process at Rocky Flats

Fluoride Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
All Residues	0.49	5.90×10^{-8}	6.66×10^{-9}	0.000634	0.0000172	2.53×10^{-7}
Building 707A						
All Residues	0.34	3.37×10^{-7}	3.65×10^{-8}	0.00701	0.000168	4.71×10^{-6}
Buildings 371 and 707A						
All Residues	0.83	3.96×10^{-7}	4.31×10^{-8}	0.00765	0.000185	4.96×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

Table D–157 provides the applicable accident scenarios, assumptions, and parameters used in determining the impacts of packaging the fluoride residue at Rocky Flats and of processing the residue using the Purex/plutonium metal (or oxide) recovery process at the Savannah River Site. **Table D–158** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with packaging the residues at Rocky Flats and processing the residues at the Savannah River Site. The risks associated with the packaging at Rocky Flats and the Purex/plutonium metal (or oxide) recovery process at the Savannah River Site are summarized in **Table D–159** and **Table D–160**. The processes at the Savannah River Site could be performed either in the F-Canyon and FB-Line or in the H-Canyon and HB-Line. Data are presented in Table D–157, Table D–158, Table D–159, and Table D–160 for both options.

Table D–157 Fluoride Residue Accident Scenario Parameters for the Purex/Plutonium Metal or Oxide Recovery Process at the Savannah River Site

Accident Scenario	*Frequency (per year)*	*Fluoride Residues*	*HEPA Banks*	*Material at Risk (grams)*
Rocky Flats Packaging of Residue for Shipment to the Savannah River Site				
Explosion	0.00005	2 drums [a]	2	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [c]	2	15,750 g
b. Loading Dock	2.0×10^{-6}	4 drums [d]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the maximum limit [e]	2	3,000 g
b. Glovebox	0.80	1 feed prep container	2	375 g
c. Loading Dock	0.001	1 drum [f]	0	3,000 g
Earthquake	0.000094	5-day supply [b]	0	15,750 g
Aircraft Crash	0.00004	The aircraft will not penetrate the building wall.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.01	2.0×10^{-6}	Elevated
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room	1.0	0.001	0.001	0.010	Ground
b. Loading Dock	0.01	0.001	0.001	0.50	Ground
Spill:					
a. Room	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.01	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake	1.0	0.002 [g]	0.30 [g]	0.10	Ground
Aircraft Crash [h]	–	–	–	–	–

Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon		
Accident Scenario	*Frequency (per year)*	*Material at Risk (grams)*
Explosion:		
a. Hydrogen	0.000015	4,000 g
b. Ion Exchange Column	0.0001	120.5 mg [j]
Nuclear Criticality [k]	0.0001	1.0×10^{19} fissions
Fire	0.00061	4,000 g

Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon				
Accident Scenario	***Frequency (per year)***		***Material at Risk (grams)***	
Spill [l]	–		–	
Earthquake: a. F-Canyon Liquid b. FB-Line Powder Molten Metal Liquid	0.000125		 12,000 g 1,000 g 1,000 g 1,000 g	
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.001 1.0	 0.005 1.0	 Elevated Elevated
Nuclear Criticality [k]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill [l]	–	–	–	–
Earthquake: a. F-Canyon Liquid b. FB-Line Powder Molten Metal Liquid	 1.0 1.0 1.0 1.0	 0.000047 0.002 0.0022 0.000047	 0.10 0.10 0.10 0.10	 Ground Ground Ground Ground
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon				
Accident Scenario	***Frequency (per year)***		***Material at Risk (grams)***	
Explosion: a. Hydrogen b. Ion Exchange Column	 0.000015 0.0001		 1,000 g 241 mg [j, m]	
Nuclear Criticality [k]	0.0001		1.0×10^{19} fissions	
Fire	0.00061		3,000 g	
Spill [j]	–		–	
Earthquake: a. H-Canyon b. HB-Line Powder Liquid	0.000182		 54,000 g 4,000 g [m] 4,000 g [m]	
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion: a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.001 1.0	 0.005 1.0	 Elevated Elevated
Nuclear Criticality [k]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill [j]	–	–	–	–

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Earthquake:				
a. H-Canyon				
Liquid	1.0	0.000047	0.10	Ground
b. HB-Line				
Powder	1.0	0.002	0.010	Ground
Liquid	1.0	0.000047	1.0	Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the residue packaging process in Building 371.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 1 container per drum of feed.

[f] 1 drum at the maximum plutonium content level.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] The aircraft will not penetrate the building walls.

[j] Respirable source term value in milligrams of plutonium released up the stack.

[k] Refer to Table D–28 for criticality accident source term.

[l] Powder spill is not a viable accident scenario for processing fluoride residue at the Savannah River Site.

[m] Duty cycle = 12.5%.

Table D–158 Summary of the Accident Analysis Doses for the Purex/Plutonium Metal or Oxide Recovery Process at the Savannah River Site

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Packaging of Residue for Shipment to the Savannah River Site							
Explosion	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.00008	2.00×10^{-7}
Fire (Room)	0.00158	Metal	0.00567	0.000567	66.2	1.58	0.0441
Fire (Dock)	0.00003	Metal	0.000108	0.0000108	1.26	0.03	0.00084
Spill (Room)	1.20×10^{-9}	Metal	3.60×10^{-9}	4.08×10^{-10}	0.0000504	1.20×10^{-6}	3.00×10^{-9}
Spill (Glovebox)	1.50×10^{-10}	Metal	4.50×10^{-10}	5.10×10^{-11}	6.30×10^{-6}	1.50×10^{-7}	3.75×10^{-10}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	1.25	Metal	4.49	0.449	52,400	1,250	34.9
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon							
Explosion (Hydrogen)	0.02	Metal	0.00068	0.00024	36.0	3.20	0.002
Explosion (Ion Exchange Column)	0.121	Metal-FB	0.00374	0.00133	193	18.1	0.0112
Criticality (Liquid)	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.200	Metal	0.0068	0.0024	360	32.0	0.02
Earthquake	0.481	Metal	0.0443	0.00818	1,590	111	10.6
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon							
Explosion (Hydrogen)	0.005	Metal	0.00016	0.000048	8.00	0.750	0.0005

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion (Ion Exchange Column)	0.241	Metal-HB	0.00699	0.00212	342	34.0	0.0224
Criticality (Liquid)	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.150	Metal	0.0048	0.00144	240	22.5	0.015
Earthquake	1.07	Metal	0.074	0.015	3,330	215	23.6

MEI = maximally exposed individual Met = meteorological data

[a] 1.0×10^{19} fissions.

Table D–159 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Purex/Plutonium Metal or Oxide Recovery Process at the Savannah River Site

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Packaging of Residue for Shipment to the Savannah River Site						
Explosion	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Fire (Room)	0.0005	1.42×10^{-9}	1.42×10^{-10}	0.0000165	3.94×10^{-7}	8.82×10^{-9}
Fire (Dock)	2.0×10^{-6}	1.08×10^{-13}	1.08×10^{-14}	1.26×10^{-9}	3.00×10^{-11}	6.72×10^{-13}
Spill (Room)	0.008	1.44×10^{-14}	1.63×10^{-15}	2.02×10^{-10}	4.80×10^{-12}	9.60×10^{-15}
Spill (Glovebox)	0.80	1.80×10^{-13}	2.04×10^{-14}	2.52×10^{-9}	6.00×10^{-11}	1.20×10^{-13}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	2.11×10^{-7}	2.11×10^{-8}	0.00246	0.0000586	2.63×10^{-6}
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon						
Explosion (Hydrogen)	0.000015	5.10×10^{-12}	1.80×10^{-12}	2.70×10^{-7}	2.40×10^{-8}	1.20×10^{-11}
Explosion (Ion Exchange Column)	0.000100	1.87×10^{-10}	6.63×10^{-11}	9.64×10^{-6}	9.04×10^{-7}	4.48×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.0000155	1.60×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.07×10^{-9}	7.32×10^{-10}	0.00011	9.76×10^{-6}	4.88×10^{-9}
Earthquake	0.000125	2.77×10^{-9}	5.11×10^{-10}	0.0000992	6.92×10^{-6}	5.29×10^{-7}
Purex Process/Plutonium Oxide Recovery at the Savannah River Site H-Canyon						
Explosion (Hydrogen)	0.000015	1.20×10^{-12}	3.60×10^{-13}	6.00×10^{-8}	5.63×10^{-9}	3.00×10^{-12}
Explosion (Ion Exchange Column)	0.0001	4.37×10^{-11}	1.33×10^{-11}	2.14×10^{-6}	2.12×10^{-7}	1.12×10^{-10}
Criticality (Liquid)	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	1.46×10^{-9}	4.39×10^{-10}	0.0000732	6.86×10^{-6}	3.66×10^{-9}
Earthquake	0.000182	2.24×10^{-9}	4.54×10^{-10}	0.0001	6.48×10^{-6}	1.14×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–160 Alternative 3 Accident Risks During Packaging at Rocky Flats and the Purex Process at Savannah River Site

Fluoride Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Packaging of Residue for Shipment to Savannah River Site						
All Residues	0.17	3.70×10^{-8}	3.70×10^{-9}	0.000432	0.0000103	4.54×10^{-7}
Purex/Plutonium Metal Recovery at Savannah River Site F-Canyon						
All Residues	0.75	4.19×10^{-9}	1.15×10^{-9}	0.000176	0.0000144	4.02×10^{-7}
Purex/Plutonium Oxide Recovery at Savannah River Site H-Canyon						
All Residues	1.58	6.63×10^{-9}	1.67×10^{-9}	0.000301	0.0000237	1.81×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.4.4 Alternative 4 – Combination of Processing Technologies

The fluoride residue is not under consideration for Alternative 4.

D.3.4.5 Filter Media Residues

D.3.4.5.1 Alternative 1 – No Action

The filter media residues processing technology considered for this alternative is neutralize/dry. This process will be conducted within glovebox lines in Building 371, Room 3701, at Rocky Flats.

Table D–161 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of using the neutralization/dry processing technology for filter media residues. **Table D–162** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with using the neutralization/dry processing technology for filter media residues. The risks associated with this processing technology are summarized in **Table D–163** and **Table D–164**.

Table D–161 Filter Media Residue Accident Scenario Parameters for the Neutralization/Dry Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Filter Media Residues*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	2	4,000 g
Nuclear Criticality	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [b]	2	1,540 g
b. Loading Dock	2.0×10^{-6}	4 drums [c]	0	6,000 g
Spill:				
a. Room [d]	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	220 g
c. Loading Dock	0.001	1 drum [e]	0	3,000 g
Earthquake	0.000094	5-day supply [b]	0	1,540 g
Aircraft Crash	0.00004	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.01	2.0×10^{-6}	Elevated
Nuclear Criticality [f]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [g]	1.0 [g]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [g]	1.0 [g]	0.10	Ground
Earthquake	1.0	0.002 [h]	0.30 [h]	0.10	Ground
Aircraft Crash [j]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content

[b] 3-day supply of feed and 2-day supply of product.

[c] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[d] Materials are opened in a glovebox. No room spill is considered.

[e] 1 drum at the maximum plutonium content level.

[f] The wet nuclear criticality is not a viable accident scenario for the neutralize/dry process in Building 371.

[g] The product of ARF×RF = 1.0×10^{-6}.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[j] Consequences enveloped by the earthquake.

Table D–162 Summary of the Accident Analysis Doses for the Neutralization/Dry Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.00008	2.00×10^{-7}
Fire (Room)	0.00924	Metal	0.0333	0.00333	388	9.24	0.259
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	4.40×10^{-10}	Metal	1.32×10^{-9}	1.50×10^{-10}	0.0000185	4.40×10^{-7}	1.10×10^{-9}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.0021
Earthquake	0.122	Metal	0.439	0.0439	5,120	122	3.42

MEI = maximally exposed individual Met = meteorological data

Table D–163 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Neutralization/Dry Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Fire (Room)	0.0005	8.32×10^{-9}	8.32×10^{-10}	0.000097	2.31×10^{-6}	5.17×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	5.28×10^{-13}	5.98×10^{-14}	7.39×10^{-9}	1.76×10^{-10}	3.52×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	2.06×10^{-8}	2.06×10^{-9}	0.000241	5.73×10^{-6}	1.28×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–164 Alternative 1 Accident Risks During Filter Media Residue Processing

Filter Media Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
HEPA Filter Media (IDC 338)	1.13	3.29×10^{-8}	3.29×10^{-9}	0.000384	9.13×10^{-6}	2.05×10^{-7}
HEPA Filter Media (All other IDCs)	0.02	5.82×10^{-10}	5.82×10^{-11}	6.79×10^{-6}	1.62×10^{-7}	3.62×10^{-9}
FUL-FLO Filter Media (IDC 331)	0.24	6.98×10^{-9}	6.98×10^{-10}	0.0000815	1.94×10^{-6}	4.34×10^{-8}
All Filter Media Residues	1.39	4.04×10^{-8}	4.04×10^{-9}	0.000472	0.0000112	2.52×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

[a] Sum of postulated accident scenario risks

D.3.4.5.2 Alternative 2 – Processing without Plutonium Separation

The filter media residues processing technologies considered for this alternative include calcination/vitrification, blend down, and sonic wash. Only HEPA filter media can be processed using the calcination/vitrification technology. All filter media can be processed using the blend down and the sonic wash technologies. The calcination/vitrification process will be performed at Rocky Flats in Building 707, Modules D, E, and F. The blend down process and the sonic wash process will be performed at Rocky Flats in Building 371, Room 3701. Building 707 is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process.

Similar accidents are applicable to all of these technologies. **Table D–165** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of processing filter media residues using the processing technologies at Rocky Flats. **Table D–166** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of filter media residues. The risks associated with these processing technologies are summarized in **Table D–167** and **Table D–168**.

Table D–165 Filter Media Residue Accident Scenario Parameters for the Calcination/ Vitrification, Blend Down, and Sonic Wash Processes at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Filter Media Residues*	*HEPA Banks*	*Material at Risk (grams)*		
				Calcination/Vitrification Process [a]	*Blend Down Process* [b]	*Sonic Wash Process* [c]
Explosion	0.00005	2 drums [d]	0/2 [f]	4,000 g	4,000 g	4,000 g
Nuclear Criticality [f]	–	–	–	–	–	–
Fire:						
a. Room	0.0005	5-day supply [g]	2	4,810 g feed + 3,206 g product [h]	1,948 [a]	1,908 g feed + 1,074 g product [j]
b. Loading Dock	2.0×10^{-6}	4 drums [k]	0	6,000 g	6,000 g	6,000 g powder
Spill:						
a. Room [l]	–	–	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	83.5 g	23.2 g	214 g
c. Loading Dock	0.001	1 drum [m]	0	3,000 g	3,000 g	3,000 g
Earthquake:						
a. Building 707	0.0026	5-day supply [g]	0	4,810 g feed + 3,206 g product [h]	1,948 g	N/A
b. Building 371	0.000094	5-day supply [g]	0	N/A	N/A 1,948 g	1,908 g feed + 1,074 g product [j]
Aircraft Crash:						
a. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–	–	N/A
b. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	N/A	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.01	1.0	Ground
b. Building 371	1.0	0.001	0.01	2.0×10^{-6}	Elevated
Nuclear Criticality [f]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.01	Ground
b. Loading Dock	0.01	0.006	0.01	05.0	Ground

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [n]	1.0 [n]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [n]	1.0 [n]	0.10	Ground
Earthquake:					
a. Building 707	1.0	0.002 [p]	0.30 [p]	0.10	Ground
b. Building 371	1.0	0.002 [p]	0.30 [p]	0.10	Ground
Aircraft Crash:					
a. Building 707 [q]	–	–	–	–	–
b. Building 371 [r]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Building 707, Modules D, E, and F.
[b] Building 371, Room 3701, or Building 707.
[c] Building 371, Room 3701.
[d] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.
[e] Building 707, 0 HEPA Banks; Building 371, 2 HEPA Banks.
[f] The wet nuclear criticality is not a viable accident scenario for the calcination/vitrification, blend down, and sonic wash technology assessments.
[g] 3-day supply of feed and 2-day supply of product.
[h] The product is glass. The effect of the vitrified product on the accident source term is negligible.
[j] 90% of the product is glass, 10% is powder. The effect of the vitrified product on the accident source term is negligible. The powder product is included in the feed accident source term.
[k] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[l] Materials are opened in a glovebox. No room spill is considered.
[m] 1 drum at the maximum plutonium content level.
[n] The product of ARF×RF = 1.0×10^{-6}.
[p] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[q] Consequences enveloped by the earthquake.
[r] The aircraft will not penetrate the building walls.

Table D–166 Summary of the Filter Media Residue Accident Analysis Doses for the Calcination/Vitrification, Blend Down, and Sonic Wash Processes at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process							
Explosion	0.04	Metal	0.096	0.0104	1,680	40.0	1.12
Fire (Room)	0.0289	Metal	0.0693	0.0075	121	28.9	0.808
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.34×10^{-11}	2.00×10^{-11}	2.51×10^{-6}	1.29×10^{-7}	3.17×10^{-11}
Spill (Dock)	0.000075	Metal	0.000180	1.95×10^{-6}	3.15	0.075	0.00210
Earthquake	0.381	Metal	0.914	0.0990	16,000	381	10.7
Blend Down Process—Building 371							
Explosion	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.00008	2.00×10^{-7}
Fire (Room)	0.0117	Metal	0.0421	0.00421	491	11.7	0.327
Fire (Dock)	0.00180	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	4.64×10^{-11}	Metal	1.39×10^{-10}	1.58×10^{-11}	1.95×10^{-6}	4.64×10^{-8}	1.16×10^{-10}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.00210
Earthquake	0.154	Metal	0.555	0.0555	6,480	154	4.32
Blend Down Process—Building 707							
Explosion	0.0400	Metal	0.0960	0.0104	1,680	40.0	1.12
Fire (Room)	0.0117	Metal	0.0281	0.00304	491	11.7	0.327
Fire (Dock)	0.00180	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Glovebox)	4.64×10^{-11}	Metal	1.48×10^{-11}	5.57×10^{-12}	6.96×10^{-7}	3.57×10^{-8}	8.82×10^{-12}
Spill (Dock)	0.0000750	Metal	0.000180	0.0000195	3.15	0.0750	0.00210

Accident Scenario	Building Source Term (grams)	Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Earthquake	0.154	Metal	0.370	0.0401	6,480	154	4.32
Sonic Wash Process							
Explosion	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.00008	2.00×10^{-7}
Fire (Room)	0.0114	Metal	0.0412	0.00412	481	11.4	0.321
Fire (Dock)	0.00180	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	4.28×10^{-10}	Metal	1.28×10^{-9}	1.46×10^{-10}	0.000018	4.28×10^{-7}	1.07×10^{-9}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.00210
Earthquake	0.151	Metal	0.544	0.0544	6,350	151	4.23

MEI = maximally exposed individual Met = meteorological data

Table D–167 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Calcination/Vitrification, Blend Down, and Sonic Wash Processes at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Calcination/Vitrification Process						
Explosion	0.00005	2.40×10^{-9}	2.60×10^{-10}	0.000042	1.00×10^{-6}	2.24×10^{-8}
Fire (Room)	0.0005	1.73×10^{-8}	1.88×10^{-9}	0.000303	7.22×10^{-6}	1.62×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	2.14×10^{-14}	8.02×10^{-15}	1.00×10^{-9}	5.14×10^{-11}	1.02×10^{-14}
Spill (Dock)	0.0010	9.00×10^{-11}	9.75×10^{-12}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.0026	1.19×10^{-6}	1.29×10^{-7}	0.0208	0.000495	0.0000111
Blend Down Process—Building 371						
Explosion	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Fire (Room)	0.0005	1.05×10^{-8}	1.05×10^{-9}	0.000123	2.92×10^{-6}	6.55×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	5.57×10^{-14}	6.31×10^{-15}	7.80×10^{-10}	1.86×10^{-11}	3.71×10^{-14}
Spill (Dock)	0.0010	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	2.61×10^{-8}	2.61×10^{-9}	0.000305	7.25×10^{-6}	1.62×10^{-7}
Blend Down Process—Building 707						
Explosion	0.00005	2.40×10^{-9}	2.60×10^{-10}	0.0000420	1.00×10^{-6}	2.24×10^{-8}
Fire (Room)	0.0005	7.01×10^{-9}	7.60×10^{-10}	0.000123	2.92×10^{-6}	6.55×10^{-8}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.8	5.94×10^{-15}	2.23×10^{-15}	2.78×10^{-10}	1.43×10^{-11}	2.82×10^{-15}
Spill (Dock)	0.001	9.00×10^{-11}	9.75×10^{-12}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.0026	4.81×10^{-7}	5.21×10^{-8}	0.00842	0.000201	$4.49\times10_{-6}$
Sonic Wash Process						
Explosion	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Fire (Room)	0.0005	1.03×10^{-8}	1.03×10^{-9}	0.00012	2.86×10^{-6}	6.41×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	5.14×10^{-13}	5.82×10^{-14}	7.19×10^{-9}	1.71×10^{-10}	3.42×10^{-13}
Spill (Dock)	0.0010	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	2.56×10^{-8}	2.56×10^{-9}	0.000298	0.0000710	1.59×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–168 Alternative 2 Accident Risks During Filter Media Residue Processing

Filter Media Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process						
HEPA Filter Media (IDC 338)	0.21	2.54×10^{-7}	2.75×10^{-8}	0.00444	0.000106	2.37×10^{-6}
HEPA Filter Media (All other IDCs)	0.01	1.21×10^{-8}	1.31×10^{-9}	0.000211	5.03×10^{-6}	1.13×10^{-7}
All HEPA Filter Media Residues	0.22	2.66×10^{-7}	2.88×10^{-8}	0.00465	0.000111	2.48×10^{-6}
Blend Down Process – Building 371						
HEPA Filter Media (IDC 338)	0.90	3.31×10^{-8}	3.31×10^{-9}	0.000386	9.19×10^{-6}	2.06×10^{-7}
HEPA Filter Media (All other IDCs)	0.02	7.35×10^{-10}	7.35×10^{-11}	8.58×10^{-6}	2.04×10^{-7}	4.58×10^{-9}
Ful Flo Filter Media (IDC 331)	0.19	6.99×10^{-9}	6.99×10^{-10}	0.0000815	1.94×10^{-6}	4.35×10^{-8}
All Filter Media Residues	1.11	4.08×10^{-8}	4.08×10^{-9}	0.000476	0.0000113	2.54×10^{-7}
Blend Down Process – Building 707						
HEPA Filter Media (IDC 338)	0.90	4.42×10^{-7}	4.79×10^{-8}	0.00773	0.000184	4.12×10^{-6}
HEPA Filter Media (All other IDCs)	0.02	9.82×10^{-9}	1.06×10^{-9}	0.000172	4.09×10^{-6}	9.16×10^{-8}
Ful Flo Filter Media (IDC 331)	0.19	9.33×10^{-8}	1.01×10^{-8}	0.00163	0.0000389	8.70×10^{-7}
All Filter Media Residues	1.11	5.45×10^{-7}	5.90×10^{-8}	0.00954	0.000227	5.09×10^{-6}
Sonic Wash Process						
HEPA Filter Media (IDC 338)	0.58	2.09×10^{-8}	2.09×10^{-9}	0.000244	5.80×10^{-6}	1.30×10^{-7}
HEPA Filter Media (All other IDCs)	0.01	3.60×10^{-10}	3.60×10^{-11}	4.20×10^{-6}	1.00×10^{-7}	2.24×10^{-9}
Ful flo Filter Media (IDC 331)	0.13	4.68×10^{-9}	4.68×10^{-10}	0.0000546	1.30×10^{-6}	2.91×10^{-8}
All Filter Media Residues	0.72	2.59×10^{-8}	2.59×10^{-9}	0.000303	7.20×10^{-6}	1.61×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.5.3 Alternative 3 – Processing with Plutonium Separation

The filter media residues processing technology considered for this alternative is mediated electrochemical oxidation. Most of the mediated electrochemical oxidation process will be performed at Rocky Flats in Building 371, Room 3701. The final calcination in the process will be performed at Rocky Flats in Building 707A, Module J.

Similar accidents are applicable to the mediated electrochemical oxidation processes in both buildings. **Table D–169** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of processing filter media residues using the mediated electrochemical oxidation technology at Rocky Flats. **Table D–170** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of filter media residues. The risks associated with this processing technology are summarized in **Table D–171** and **Table D–172**.

Table D–169 Filter Media Residue Accident Scenario Parameters for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Filter Media Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				MEO Process	
				Building 371	*Building 707A [a]*
Explosion (Acetylene)	0.00005	2 drums [b]	2/0 [c]	4,000 g powder	2,000 g
Explosion (Ion Exchange Column)	0.0001	Solution	2	0.245 mg [d]	N/A
Nuclear Criticality [e]	0.0001	Solution	2	1.0×10^{19} fissions	N/A [f]
Fire:					
a. Room	0.0005	5-day supply [g]	2	5,572 g	6,000 g
b. Loading Dock	2.0×10^{-6}	4 drums [h]	0	6,000 g	4,000 g
Spill:					
a. Room [j]	–	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	200 g	1,000 g
c. Loading Dock	0.0010	1 drum [k]	0	3,000 g	1,000 g
Earthquake:					
a. Building 371	0.000094	5-day supply [g]	0	5,572 g	N/A
b. Building 707A	0.0026	5-day supply [g]	0	N/A	6,000 g
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion (Acetylene):					
a. Building 707A	1.0	0.001	0.01	1.0	Ground
b. Building 371	1.0	0.001	0.01	2.0×10^{-6}	Elevated
Explosion (Ion Exchange Column) [l]	1.0	1.0	1.0	1.0	Elevated
Nuclear Criticality [e, f]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.0060	0.01	0.10	Ground
b. Loading Dock	0.01	0.0060	0.01	0.50	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [m]	1.0 [m]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [m]	1.0 [m]	0.10	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.002 [d]	0.30 [d]	0.10	Ground

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Aircraft Crash:					
a. Building 707A [n]	–	–	–	–	–
b. Building 371 [p]	–	–	–	–	–

MEO = mediated electrochemical oxidation N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1,000-g product container transported from Building 371 to Building 707A for processing.
[b] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.
[c] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.
[d] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[e] Refer to Table D–28 for Building 371 mediated electrochemical oxidation criticality accident source term.
[f] The wet nuclear criticality is not a viable accident scenario for the mediated electrochemical oxidation process in Building 707A.
[g] 3-day supply of feed and 2-day supply of product.
[h] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[j] Materials are opened in a glovebox. No room spill is considered.
[k] 1 drum at the maximum plutonium content level.
[l] Respirable source term value in milligrams of plutonium released up the stack.
[m] The product of ARF×RF = 1.0×10^{-6}.
[n] Consequences enveloped by the earthquake.
[p] The aircraft will not penetrate the building walls.

Table D–170 Summary of the Accident Analysis Doses for the Mediated Electrochemical Oxidation Process at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371							
Explosion (Acetylene)	8.00×10^{-8}	Metal	2.40×10^{-7}	2.72×10^{-8}	0.00336	0.00008	2.00×10^{-7}
Explosion (Ion Exchange Column)	0.000245	Metal	0.000735	0.0000833	10.3	0.245	0.000613
Criticality (Liquid)	[a]	–	0.790	0.110	6,980	252	0.321
Fire (Room)	0.0334	Metal	0.120	0.012	1,400	33.4	0.936
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	4.00×10^{-10}	Metal	1.20×10^{-9}	1.36×10^{-10}	0.0000168	4.00×10^{-7}	1.00×10^{-9}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.0021
Earthquake	0.441	Metal	1.59	0.159	18,500	441	12.4
Building 707A							
Explosion (Acetylene)	0.02	Oxide	0.024	0.0026	500	12.0	0.420
Fire (Room)	0.036	Oxide	0.0432	0.00468	900	21.6	0.756
Fire (Dock)	0.0012	Oxide	0.00144	0.000156	30.0	0.720	0.0252
Spill (Glovebox)	2.00×10^{-9}	Oxide	3.20×10^{-10}	1.20×10^{-10}	0.0000174	9.00×10^{-7}	2.80×10^{-10}
Spill (Dock)	0.000025	Oxide	0.00003	3.25×10^{-6}	0.625	0.015	0.000525
Earthquake	0.475	Oxide	0.570	0.0618	11,900	285	9.98

MEI = maximally exposed individual Met = meteorological data
[a] 1.0×10^{19} fissions.

Table D–171 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371						
Explosion (Acetylene)	0.00005	6.00×10^{-15}	6.80×10^{-16}	8.40×10^{-11}	2.00×10^{-12}	4.00×10^{-15}
Explosion (Ion Exchange Column)	0.0001	3.68×10^{-11}	4.17×10^{-12}	5.15×10^{-7}	1.23×10^{-8}	2.45×10^{-11}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	3.01×10^{-8}	3.01×10^{-9}	0.000351	8.36×10^{-6}	1.87×10^{-7}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	4.80×10^{-13}	5.44×10^{-14}	6.72×10^{-9}	1.60×10^{-10}	3.20×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	7.47×10^{-8}	7.47×10^{-9}	0.000871	0.0000207	4.65×10^{-7}
Building 707A						
Explosion (Acetylene)	0.00005	6.00×10^{-10}	6.50×10^{-11}	0.0000125	3.00×10^{-7}	8.40×10^{-9}
Fire (Room)	0.0005	1.08×10^{-8}	1.17×10^{-9}	0.000225	5.40×10^{-6}	1.51×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.44×10^{-12}	1.56×10^{-13}	3.00×10^{-8}	7.20×10^{-10}	2.02×10^{-11}
Spill (Glovebox)	0.80	1.28×10^{-13}	4.80×10^{-14}	6.96×10^{-9}	3.60×10^{-10}	8.96×10^{-14}
Spill (Dock)	0.001	1.50×10^{-11}	1.63×10^{-12}	3.13×10^{-7}	7.50×10^{-9}	2.10×10^{-10}
Earthquake	0.0026	7.41×10^{-7}	8.03×10^{-8}	0.0154	0.000371	0.0000104

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–172 Alternative 3 Accident Risks During Mediated Electrochemical Oxidation Processing at Rocky Flats

Filter Media Residue	*Process Duration (yr)*	*Risks [a]*				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371						
HEPA Filter Media (IDC 338)	0.31	4.48×10^{-8}	4.96×10^{-9}	0.000488	0.0000129	2.06×10^{-7}
HEPA Filter Media (All other IDCs)	0.01	1.44×10^{-9}	1.60×10^{-10}	0.0000157	4.18×10^{-7}	6.66×10^{-9}
Ful Flo Filter Media (IDC 331)	0.07	1.01×10^{-8}	1.12×10^{-9}	0.00011	2.92×10^{-6}	4.66×10^{-8}
All Filter Media Residues	0.39	5.63×10^{-8}	6.24×10^{-9}	0.000614	0.0000162	2.59×10^{-7}

Filter Media Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 707A						
HEPA Filter Media (IDC 338)	0.38	2.86×10^{-7}	3.10×10^{-8}	0.00596	0.000143	4.00×10^{-6}
HEPA Filter Media (All other IDCs)	0.01	7.53×10^{-9}	8.15×10^{-10}	0.000157	3.76×10^{-6}	1.05×10^{-7}
Ful Flo Filter Media (IDC 331)	0.08	6.02×10^{-8}	6.52×10^{-9}	0.00125	0.0000301	8.43×10^{-7}
All Filter Media Residues	0.47	3.54×10^{-7}	3.83×10^{-8}	0.00737	0.000177	4.95×10^{-6}
Buildings 371 and 707A						
HEPA Filter Media (IDC 338)	–	3.31×10^{-7}	3.59×10^{-8}	0.00645	0.000156	4.21×10^{-6}
HEPA Filter Media (All other IDCs)	–	8.97×10^{-7}	9.75×10^{-10}	0.000173	4.18×10^{-6}	1.12×10^{-7}
Ful Flo Filter Media (IDC 331)	–	7.03×10^{-8}	7.64×10^{-9}	0.00136	0.000033	8.90×10^{-7}
All Filter Media Residues	–	4.10×10^{-7}	4.46×10^{-8}	0.00798	0.000193	5.21×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.5.4 Alternative 4 – Combination of Processing Technologies

The full flow filter media residue, IDC 331, is not under consideration for Alternative 4. The high-efficiency particulate air filter media residue processing technologies considered for Alternative 4 are the neutralization/dry process for IDC 338 and the repackaging process for all other IDCs. The neutralization/dry process technology accident descriptions, consequences and risks are identical to those presented in Section D.3.4.5.1, Alternative 1 - No Action. Refer to Section D.3.4.5.1 for details.

The repackaging process will be performed in Rocky Flats Building 707, Module E. **Table D-173** provides the applicable accident scenarios, assumptions, and paramenters used in determining the impacts of repackaging the high-efficiency particulate air filter media residue (not including IDC 338) at Rocky Flats. **Table D-174** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the repackaging of this high-efficiency particulate air filter media residue. The risks associated with repackaging are presented in **Table D-175** and are summarized for the processing of all filter media residue in **Table D-176.**

Table D–173 High-Efficiency Particulate Air Filter Media Residue (IDC 338 excluded) Accident Scenario Parameters for the Repackaging Process at Rocky Flats

Accident Scenario	Frequency (per year)	HEPA Filter Media Residue	HEPA Banks	Material at Risk (grams)
Explosion	0.00005	2 drums [a]	2	400 g

Accident Scenario	*Frequency (per year)*	*HEPA Filter Media Residue*	*HEPA Banks*	*Material at Risk (grams)*
Nuclear Criticality [b]	-	-	-	-
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [c] 4 drums [a]	 2 0	 1,856 g 800 g
Spill: a. Room b. Glovebox c. Loading Dock	 [d] 0.8 0.001	 - 1 feed prep container 1 drum [e]	 - 2 0	 - 23.2 g 200 g
Earthquake	0.0026	5-day supply [c]	0	1,856 g
Aircraft Crash	-	Conseuences enveloped by the earthquake.	-	-

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.01	1.0	Ground
Nuclear Criticality	-	-	-	-	-
Fire: a. Room b. Loading Dock	 1.0 0.01	 0.006 0.006	 0.01 0.01	 0.1 0.5	 Ground Ground
Spill: a. Glovebox b. Loading Dock	 1.0 0.25	 1.0×10^{-6} [f] 1.0×10^{-6} [f]	 1.0 [f] 1.0 [f]	 2.0×10^{-6} 0.1	 Elevated Ground
Earthquake	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash [h]	-	-	-	-	-

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Each drum with a plutonium content levelof 200 g.

[b] The wet criticality is not a viable accident scenario for this process.

[c] 3-day supply of feed and 2-day supply of product.

[d] Materials are opened in a glovebox. No room spill is considered.

[e] 1 drum with a plutonium content level of 200 g.

[f] The product of ARFxRF = 1.0×10^{-6}.

[g] Add 0.000192 to all ARFxRF values for the resuspension of respirable particulates after the earthquake (e.g., ARFxRF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

Table D–174 Summary of the HEPA Filter Media Residue (IDC 338 excluded) Accident Doses for the Repackaging Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.00400	Metal	0.00960	0.00104	168	4.00	0.112
Fire (Room)	0.0111	Metal	0.0267	0.00290	468	11.1	0.312
Fire (Dock)	0.000240	Metal	0.000576	0.0000624	10.1	0.240	0.00672
Spill (Glovebox)	4.64×10^{-11}	Metal	1.48×10^{-11}	5.57×10^{-12}	6.96×10^{-7}	3.57×10^{-8}	8.82×10^{-12}

Accident Scenario	Building Source Term		MEI (rem)		Population (person-rem)		Worker (rem)
	(grams)	Type	95% Met	50% Met	95% Met	50% Met	50% Met
Spill (Dock)	5.00×10^{-6}	Metal	0.0000120	1.30×10^{-6}	0.0210	0.00500	0.000140
Earthquake	0.147	Metal	0.353	0.0382	6,170	147	4.12

MEI = maximally exposed individual Met = meteorological data

Table D–175 Summary of the Repackaging Process Accident Analysis Risks in Terms of Latent Cancer Fatalities per year

Accident Scenario	Accident Frequency (per year)	MEI (rem)		Population (person-rem)		Worker (rem)
		95% Met	50% Met	95% Met	50% Met	50% Met
Explosion	0.00005	2.40×10^{-10}	2.60×10^{-11}	4.20×10^{-6}	1.00×10^{-7}	2.24×10^{-9}
Fire (Room)	0.0005	6.68×10^{-9}	7.24×10^{-10}	0.000117	2.78×10^{-6}	6.24×10^{-8}
Fire (Dock)	2.0×10^{-6}	5.76×10^{-13}	6.24×10^{-14}	1.01×10^{-8}	2.40×10^{-10}	5.38×10^{-12}
Spill (Glovebox)	0.8	5.94×10^{-15}	2.23×10^{-15}	2.78×10^{-10}	1.43×10^{-11}	2.82×10^{-15}
Spill (Dock)	0.001	6.00×10^{-12}	6.50×10^{-13}	1.05×10^{-7}	2.50×10^{-9}	5.60×10^{-11}
Earthquake	0.0026	4.59×10^{-7}	4.97×10^{-8}	0.00803	0.000191	4.28×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

Table D–176 Alternative 4 Accident Risks During Filter Media Residue Processing

Filter Media Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
HEPA Filter Media (IDC 338)	1.13	3.29×10^{-8}	3.29×10^{-9}	0.000384	9.13×10^{-6}	2.05×10^{-7}
HEPA Filter Media (All other IDCs)	0.021	9.78×10^{-9}	1.06×10^{-9}	0.000171	4.07×10^{-6}	9.12×10^{-8}
Sum	1.51	4.27×10^{-8}	4.35×10^{-9}	0.000555	0.0000321	2.96×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.6 Sludge Residues

D.3.4.6.1 Alternative 1 – No Action

The sludge residues processing technology considered for this alternative is filter/dry. The processing of the sludge residues will be conducted within glovebox lines at Rocky Flats in Building 371, Room 3701.

Table D–177 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of the filter/dry processing of sludge residues at Rocky Flats. **Table D–178** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of sludge residues at Rocky Flats. The risks associated with this processing technology are summarized in **Table D–179** and **Table D–180**.

Table D–177 Sludge Residue Accident Scenario Parameters for the Filter/Dry Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Sludge Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Sludge Residue (IDCs 089, 099, 332)	*Sludge Residue (All other IDCs)*
Explosion	0.00005	2 drums [a]	0	4,000 g	4,000 g
Nuclear Criticality	–	–	–	–	–
Fire:					
a. Room	0.0005	5-day supply [b]	2	1,827 g	2,426 g
b. Loading Dock	2.0×10^{-6}	4 drums [c]	0	6,000 g	6,000 g
Spill:					
a. Room	0.008	1 container at the maximum limit [d]	2	600 g	600 g
b. Glovebox	0.8	1 feed prep container	2	87 g	89 g
c. Loading Dock	0.001	1 drum [e]	0	3,000 g	3,000 g
Earthquake	0.000094	5-day supply [b]	0	1,827 g	2,426 g
Aircraft Crash	0.00004	Consequences enveloped by the earthquake.	–	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.10	2.0×10^{-6}	Elevated
Nuclear Criticality [f]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.5	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.5	0.1	Ground
Earthquake	1.0	0.002 [g]	0.3 [g]	0.1	Ground
Aircraft Crash [h]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content

[b] 3-day supply of feed and 2-day supply of product.

[c] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[d] 5 containers per drum of feed.

[e] 1 drum at the maximum plutonium content level.

[f] The wet nuclear criticality is not a viable accident scenario for the filter/dry process in Building 371.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

Table D–178 Summary of the Sludge Residue Accident Analysis Doses for the Filter/Dry Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Process Sludge Residue (IDCs 089, 099, 332)							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.011	Metal	0.0395	0.00395	460	11.0	0.307
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.8	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.000012	3.00×10^{-8}
Spill (Glovebox)	1.74×10^{-9}	Metal	5.22×10^{-9}	5.92×10^{-10}	0.0000731	1.74×10^{-6}	4.35×10^{-9}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.0	0.084
Earthquake	0.145	Metal	0.521	0.0521	6,080	145	4.05
Process Sludge Residue (All other IDCs)							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.0146	Metal	0.0524	0.00524	611	14.6	0.408
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.000012	3.00×10^{-8}
Spill (Glovebox)	1.78×10^{-9}	Metal	5.34×10^{-9}	6.05×10^{-10}	0.0000748	1.78×10^{-6}	4.45×10^{-9}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	0.192	Metal	0.692	0.0692	8,070	192	5.38

MEI = maximally exposed individual Met = meteorological data

Table D–179 Summary of the Sludge Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Filter/Dry Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Process Sludge Residue (IDCs 089, 099, 332)						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	9.87×10^{-9}	9.87×10^{-10}	0.000115	2.74×10^{-6}	6.14×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}
Spill (Glovebox)	0.8	2.09×10^{-12}	2.37×10^{-13}	2.92×10^{-8}	6.96×10^{-10}	1.39×10^{-12}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	2.45×10^{-8}	2.45×10^{-9}	0.000286	6.80×10^{-6}	1.52×10^{-7}
Process Sludge Residue (all other IDCs)						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	1.31×10^{-8}	1.31×10^{-9}	0.000153	3.64×10^{-6}	8.15×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}
Spill (Glovebox)	0.80	2.14×10^{-12}	2.42×10^{-13}	2.99×10^{-8}	7.12×10^{-10}	1.42×10^{-12}

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	3.25×10^{-8}	3.25×10^{-9}	0.000379	9.03×10^{-6}	2.02×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–180 Alternative 1 Accident Risks During Sludge Residue Processing

Sludge Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
IDCs 089, 099, 332	0.01	3.98×10^{-10}	3.98×10^{-11}	4.64×10^{-6}	1.10×10^{-7}	2.47×10^{-9}
All other IDCs	0.20	1.02×10^{-8}	1.02×10^{-9}	0.000119	2.83×10^{-6}	6.35×10^{-8}
All Residues	0.21	1.06×10^{-8}	1.06×10^{-9}	0.000124	2.94×10^{-6}	6.60×10^{-8}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.6.2 Alternative 2 – Processing without Plutonium Separation

The sludge residues processing technologies considered for this alternative are calcination/vitrification and blend down. The calcination/vitrification process will be performed at Rocky Flats in Building 707, Modules D, E, and F. The blend down process will be performed at Rocky Flats in Building 707, Module E. Building 371 is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process. Similar accidents are applicable to both these technologies. **Table D–181** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of sludge processing technologies at Rocky Flats. **Table D–182** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of sludge residues. The risks associated with these processing technologies are summarized in **Table D–183** and **Table D–184**.

Table D–181 Sludge Residue Accident Scenario Parameters for the Calcination/Vitrification Process and Blend Down Process at Rocky Flats

Accident Scenario	Frequency (per year)	Sludge Residues	HEPA Banks	Material at Risk (grams)		
				Calcination/ Vitrification Process [a]	Blend Down Process [b]	
					Blend Down Process (IDCs 089, 099, 332)	Blend Down Process (All other IDCs)
Explosion	0.00005	2 drums [c]	2/0 [d]	4,000 g	4,000 g	4,000 g
Nuclear Criticality [e]	–	–	–	–	–	–
Fire:						
a. Room	0.0005	5-day supply [f]	2	4,810 g feed + 3,206 g product [g]	551 g	8,016 g
b. Loading Dock	2.0×10^{-6}	4 drums [h]	0	6,000 g	6,000 g	6,000 g
Spill:						
a. Room	0.008	1 container at the maximum limit [j]	2	600 g	600 g	600 g
b. Glovebox	0.8	1 feed prep container	2	83.5 g	83.5 g	83.5 g
c. Loading Dock	0.001	1 drum [k]	0	3,000 g	3,000 g	3,000 g

Accident Scenario	*Frequency (per year)*	*Sludge Residues*	*HEPA Banks*	*Material at Risk (grams)*		
				Calcination/ Vitrification Process [a]	*Blend Down Process* [b]	
					Blend Down Process (IDCs 089, 099, 332)	*Blend Down Process (All other IDCs)*
Earthquake:						
a. Building 707	0.0026	5-day supply [f]	0	4,810 g feed + 3,206 g product [g]	551 g	8,016 g
b. Building 371	0.000094	5-day supply [f]	0	N/A	551 g	8,016 g
Aircraft Crash:						
a. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–	–	–
b. Building 371	0.00004	The aircraft will not penetrate the building walls.	–	–	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1	0.001	0.1	1	Ground
b. Building 371	1	0.001	0.1	2.0×10^{-6}	Elevated
Nuclear Criticality [e]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Room	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake	1.0	0.002 [l]	0.30 [l]	0.10	Ground
Aircraft Crash					
a. Building 707 [m]	–	–	–	–	–
b. Building 371 [n]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Building 707, Modules D, E, and F, or Building 707.
[b] Building 707, Module E.
[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.
[d] Building 371, 2 HEPA Banks; Building 707, 0 HEPA Banks.
[e] The wet nuclear criticality is not a viable accident scenario for the calcination/vitrification and blend down technology assessments.
[f] 3-day supply of feed and 2-day supply of product.
[g] The product is glass. The effect of the vitrified product on the accident source term is negligible.
[h] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[j] 5 containers per drum of feed.
[k] 1 drum at the maximum plutonium content level.
[l] Add 0.000192 to all (ARF×RF) values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[m] Consequences enveloped by the earthquake.
[n] The aircraft will not penetrate the building walls.

Table D–182 Summary of the Sludge Residue Accident Analysis Doses for the Calcination/Vitrification Process and Blend Down Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0289	Metal	0.0693	0.0075	1,210	28.9	0.808
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.84×10^{-9}	1.44×10^{-9}	0.00018	9.24×10^{-6}	2.28×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.34×10^{-10}	2.00×10^{-10}	0.0000251	1.29×10^{-6}	3.17×10^{-10}

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Spill (Dock)	0.003	Metal	0.0072	0.00078	126	3.00	0.084
Earthquake	0.381	Metal	0.914	0.099	16,000	381	10.7
Blend Down Process (IDCs 089, 099, 332)—Building 707							
Explosion	0.400	Metal	0.96	0.104	16,800	400	11.2
Fire (Room)	0.00331	Metal	0.00793	0.00086	139	3.31	0.0926
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.84×10^{-9}	1.44×10^{-9}	0.00018	9.24×10^{-6}	2.28×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.34×10^{-10}	2.00×10^{-10}	0.0000251	1.29×10^{-6}	3.17×10^{-10}
Spill (Dock)	0.00300	Metal	0.0072	0.00078	126	3.0	0.084
Earthquake	0.0436	Metal	0.105	0.0113	1,830	43.6	1.22
Blend Down Process (All other IDCs)—Building 707							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0481	Metal	0.115	0.0125	2,020	48.1	1.35
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.84×10^{-9}	1.44×10^{-9}	0.00018	9.24×10^{-6}	2.28×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.34×10^{-10}	2.00×10^{-10}	0.0000251	1.29×10^{-6}	3.17×10^{-10}
Spill (Dock)	0.003	Metal	0.0072	0.00078	126	3.00	0.084
Earthquake	0.635	Metal	1.52	0.165	26,700	635	17.8
Blend Down Process (IDCs 089, 099, 332)—Building 371							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.00331	Metal	0.0119	0.00119	139	3.31	0.0926
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.8	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.000012	3.00×10^{-8}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.01×10^{-9}	5.68×10^{-10}	0.0000701	1.67×10^{-6}	4.18×10^{-9}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	0.0436	Metal	0.157	0.0157	1,830	43.6	1.22
Blend Down Process (All other IDCs)—Building 371							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.000800	2.00×10^{-6}
Fire (Room)	0.0481	Metal	0.173	0.0173	2,020	48.1	1.35
Fire (Dock)	0.00180	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.0000120	3.00×10^{-8}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.01×10^{-9}	5.68×10^{-10}	0.0000701	1.67×10^{-6}	4.18×10^{-9}
Spill (Dock)	0.00300	Metal	0.0108	0.00108	126	3.00	0.0840
Earthquake	0.635	Metal	2.29	0.229	26,700	635	17.8

MEI = maximally exposed individual Met = meteorological data

Table D–183 Summary of the Sludge Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Calcination/Vitrification Process and Blend Down Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	1.73×10^{-8}	1.88×10^{-9}	0.000303	7.22×10^{-6}	1.62×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.54×10^{-14}	5.76×10^{-15}	7.20×10^{-10}	3.70×10^{-11}	7.30×10^{-15}
Spill (Glovebox)	0.80	2.14×10^{-13}	8.02×10^{-14}	1.00×10^{-8}	5.14×10^{-10}	1.02×10^{-13}
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	8.23×10^{-6}	1.29×10^{-7}	0.0208	0.000495	0.0000111
Blend Down Process (IDCs 089, 099, 332)—Building 707						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	1.98×10^{-9}	2.15×10^{-10}	0.0000347	8.27×10^{-7}	1.85×10^{-8}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.54×10^{-14}	5.76×10^{-15}	7.20×10^{-10}	3.70×10^{-11}	7.30×10^{-15}
Spill (Glovebox)	0.8	2.14×10^{-13}	8.02×10^{-14}	1.00×10^{-8}	5.14×10^{-10}	1.02×10^{-13}
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	1.36×10^{-7}	1.48×10^{-8}	0.00238	0.0000567	1.27×10^{-6}
Blend Down Process (All other IDCs)—Building 707						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	2.89×10^{-8}	3.13×10^{-9}	0.000505	0.000012	2.69×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.54×10^{-14}	5.76×10^{-15}	7.20×10^{-10}	3.70×10^{-11}	7.30×10^{-15}
Spill (Glovebox)	0.80	2.14×10^{-13}	8.02×10^{-14}	1.00×10^{-8}	5.14×10^{-10}	1.02×10^{-13}
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	1.98×10^{-6}	2.15×10^{-7}	0.0347	0.000825	0.0000185
Blend Down Process (IDCs 089, 099, 332)—Building 371						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	2.98×10^{-9}	2.98×10^{-10}	0.0000347	8.27×10^{-7}	1.85×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}
Spill (Glovebox)	0.8	2.00×10^{-12}	2.27×10^{-13}	2.81×10^{-8}	6.68×10^{-10}	1.34×10^{-12}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	7.38×10^{-9}	7.38×10^{-10}	0.0000861	2.05×10^{-6}	4.59×10^{-8}
Blend Down Process (All other IDCs) —Building 371						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	4.33×10^{-8}	4.33×10^{-9}	0.000505	0.0000120	2.69×10^{-7}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}
Spill (Glovebox)	0.8	2.00×10^{-12}	2.27×10^{-13}	2.81×10^{-8}	6.68×10^{-10}	1.34×10^{-12}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.0000630	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	1.07×10^{-7}	1.07×10^{-8}	0.00125	0.0000298	6.68×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–184 Alternative 2 Accident Risks During Sludge Residue Processing

Sludge Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Vitrification Process						
IDCs 088, 099, 332	0.002	2.47×10^{-9}	2.67×10^{-10}	0.0000432	1.03×10^{-6}	2.30×10^{-8}
All other IDCs	0.062	7.65×10^{-8}	8.28×10^{-9}	0.00134	0.0000319	7.14×10^{-7}
All Sludge Residues	0.064	7.89×10^{-8}	8.55×10^{-9}	0.00138	0.0000329	7.37×10^{-7}
Blend Down Process – Building 707						
IDCs 088, 099, 332	0.035	5.80×10^{-9}	6.28×10^{-10}	0.000102	2.42×10^{-6}	5.41×10^{-8}
All other IDCs	0.062	1.26×10^{-7}	1.37×10^{-8}	0.00221	0.0000526	1.18×10^{-6}
All Sludge Residues	0.097	1.32×10^{-7}	1.43×10^{-8}	0.00231	0.000055	1.23×10^{-6}
Blend Down Process – Building 371						
IDCs 088, 099, 332	0.035	5.52×10^{-10}	5.52×10^{-11}	6.44×10^{-6}	1.53×10^{-7}	3.43×10-9
All other IDCs	0.062	9.68×10^{-9}	9.68×10^{-10}	0.000113	2.69×10^{-6}	6.02×10^{-8}
All Sludge Residues	0.097	1.02×10^{-8}	1.02×10^{-9}	0.000119	2.84×10^{-6}	6.37×10^{-8}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.6.3 Alternative 3 – Processing with Plutonium Separation

The sludge residues processing technology considered for this alternative is the acid dissolution/plutonium oxide recovery process. Sludge residue IDCs 089, 099, and 332 can not be processed using the acid dissolution/ plutonium oxide recovery technology. Most of the process will be performed at Rocky Flats in Building 371, Room 3701. The final calcination will be performed at Rocky Flats in Building 707A, Module J.

Similar accidents are applicable to the process in both buildings. **Table D–185** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of the sludge processing technology at Rocky Flats. **Table D–186** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of sludge residues. The risks

associated with the acid dissolution/plutonium oxide recovery process are summarized in **Table D–187** and **Table D–188**.

Table D–185 Sludge Residue (IDCs 089, 090, 332 excluded) Accident Scenario Parameters for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Sludge Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Acid Dissolution/Plutonium Oxide Recovery Process	
				Building 371	*Building 707A* [a]
Explosion	0.00005	2 drums	2/0 [b]	4,000 g [c]	2,000 g
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	N/A [d]
Fire:					
a. Room	0.0005	5-day supply [e]	2	560 g	8,000 g
b. Loading Dock	2.0×10^{-6}	4 drums	0	6,000 g [f]	4,000 g
Spill:					
a. Room	0.008	1 container at the maximum limit [g]	2	600 g	N/A [h]
b. Glovebox	0.8	1 feed prep container	2	20 g	1,000 g
c. Loading Dock	0.001	1 drum	0	3,000 [j]	1,000 g
Earthquake:					
a. Building 371	0.000094	5-day supply [e]	0	560 g	N/A
b. Building 707A	0.0026	5-day supply [e]	0	N/A	8,000 g
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707A	1.0	0.001	0.010	1.0	Ground
b. Building 371	1.0	0.001	1.0	2.0×10^{-6}	Elevated
Nuclear Criticality [d, k]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.006	0.01	0.010	Ground
b. Loading Dock	0.01	0.006	0.01	5.0	Ground
Spill:					
a. Room [h]	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.002 [l]	0.30 [l]	0.10	Ground
Aircraft Crash:					
a. Building 707A [m]	–	–	–	–	–
b. Building 371 [n]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1,000-g product containers are transported from Building 371 to Building 707A for processing.

[b] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.

[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[d] The wet nuclear criticality is not a viable accident scenario for the process in Building 707A.

[e] 3-day supply of feed and 2-day supply of product.
[f] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[g] 5 containers per drum of feed.
[h] Materials are opened in a glovebox in Building 707A. No room spill is considered.
[j] 1 drum at the maximum plutonium content level.
[k] Refer to Table D–28 for Building 371 criticality accident source term.
[l] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[m] Consequences enveloped by the earthquake.
[n] The aircraft will not penetrate the building walls.

Table D–186 Summary of the Sludge Residue (IDCs 089, 099, 332 excluded) Accident Analysis Doses for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371							
Explosion	8.00×10^{-7}	Oxide	1.20×10^{-6}	1.36×10^{-7}	0.02	0.00048	1.44×10^{-6}
Criticality (Liquid)	[a]	–	0.790	0.110	6,980	252	0.321
Fire (Room)	0.00336	Metal	0.0121	0.00121	141	3.36	0.0941
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Oxide	2.16×10^{-8}	2.16×10^{-9}	0.0003	7.20×10^{-6}	2.52×10^{-7}
Spill (Glovebox)	4.00×10^{-10}	Oxide	6.00×10^{-10}	6.80×10^{-11}	0.00001	2.40×10^{-7}	7.20×10^{-10}
Spill (Dock)	0.003	Oxide	0.0054	0.00054	75.0	1.80	0.063
Earthquake	0.0444	Oxide	0.0798	0.00798	1,110	26.6	0.931
Building 707A							
Explosion	0.200	Oxide	0.240	0.026	5,000	120	4.20
Fire (Room)	0.048	Oxide	0.0576	0.00624	1,200	28.8	1.01
Fire (Dock)	0.0012	Oxide	0.00144	0.000156	30.0	0.720	0.0252
Spill (Glovebox)	2.00×10^{-8}	Oxide	3.20×10^{-9}	1.20×10^{-9}	0.000174	9.00×10^{-6}	2.80×10^{-9}
Spill (Dock)	0.001	Oxide	0.0012	0.00013	25.0	0.600	0.021
Earthquake	0.634	Oxide	0.760	0.0824	15,800	380	13.3

MEI = maximally exposed individual Met = meteorological data

Table D–187 Summary of the Sludge Residue (IDCs 089, 099, 332 excluded) Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Acid Dissolution/Plutonium Oxide Recovery Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
Explosion	0.00005	3.00×10^{-14}	3.40×10^{-15}	5.00×10^{-10}	1.20×10^{-11}	2.88×10^{-14}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	3.02×10^{-9}	3.02×10^{-10}	0.0000353	8.40×10^{-7}	1.88×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	8.64×10^{-14}	8.64×10^{-15}	1.20×10^{-9}	2.88×10^{-11}	8.06×10^{-13}
Spill (Glovebox)	0.80	2.40×10^{-13}	2.72×10^{-14}	4.00×10^{-9}	9.60×10^{-11}	2.30×10^{-13}
Spill (Dock)	0.001	2.70×10^{-9}	2.70×10^{-10}	0.0000375	9.00×10^{-7}	2.52×10^{-8}
Earthquake	0.000094	3.75×10^{-9}	3.75×10^{-10}	0.0000521	1.25×10^{-6}	3.50×10^{-8}
Building 707A						
Explosion	0.00005	6.00×10^{-9}	6.50×10^{-10}	0.000125	3.00×10^{-6}	8.40×10^{-8}
Fire (Room)	0.0005	1.44×10^{-8}	1.56×10^{-9}	0.0003	7.20×10^{-6}	2.02×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.44×10^{-12}	1.56×10^{-13}	3.00×10^{-8}	7.20×10^{-10}	2.02×10^{-11}
Spill (Glovebox)	0.80	1.28×10^{-12}	4.80×10^{-13}	6.96×10^{-8}	3.60×10^{-9}	8.96×10^{-13}
Spill (Dock)	0.001	6.00×10^{-10}	6.50×10^{-11}	0.0000125	3.00×10^{-7}	8.40×10^{-9}
Earthquake	0.0026	9.88×10^{-7}	1.07×10^{-7}	0.0206	0.000494	0.0000138

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–188 Alternative 3 Accident Risks During Acid Dissolution /Plutonium Oxide Recovery Processing at Rocky Flats

Sludge Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
IDCs 089, 099, 332	N/A	---	---	---	---	---
All other IDCs	0.88	4.31×10^{-8}	5.67×10^{-9}	0.000417	0.0000137	8.09×10^{-8}
Building 707A						
IDCs 089, 099, 332	N/A	---	---	---	---	---
All other IDCs	0.061	6.16×10^{-8}	6.67×10^{-9}	0.00128	0.0000308	8.62×10^{-7}
Buildings 371 and 707A						
IDCs 089, 099, 332	N/A	---	---	---	---	---
All other IDCs	–	1.05×10^{-7}	1.23×10^{-8}	0.00170	0.0000445	9.43×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable
[a] Sum of postulated accident scenario risks

D.3.4.6.4 Alternative 4 – Combination of Processing Technologies

Sludge residue processing technologies considered for this alternative are the filter/dry process and the repackaging process. Sludge residue IDCs 089, 099, and 332 will be processed with the repackaging technology. The repackaging process will be performed in Rocky Flats Building 707, Module E. The remaining sludge residue will be processed using the filter/dry technology. The filter/dry process technology accident descriptions, consequences and risks are identical to those presented in Section D.3.4.6.1, Alternative 1 - No Action. Refer to Section D.3.4.6.1 for details.

Table D–189 provides the applicable accident scenarios, assumptions, and paramenters used in determining the impacts of repackaging the sludge residue (not including IDCs 089, 099, and 332) at Rocky Flats. **Table D–190** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with repackaging of this sludge residue. The risks associated with repackaging are presented in **Table D–191** and are summarized for the processing of all sludge residue in **Table D-192.**

Table D–189 Sludge Residue (IDCs 089, 099, 332 excluded) Accident Scenario Parameters for the Repackage Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Sludge Residue*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	2	2,000 g
Nuclear Criticality [b]	-	-	-	-
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [c] 4 drums [a]	 2 0	 1,202 g 4,000 g
Spill: a. Room b. Glovebox c. Loading Dock	 0.008 0.8 0.001	 1 containter at the maximum limit [d] 1 feed prep container 1 drum [e]	 2 2 0	 250 g 167 g 1,000 g
Earthquake	0.0026	5-day supply [c]	0	1,202 g
Aircraft Crash	-	Conseuences enveloped by the earthquake.	-	-

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.1	1.0	Ground
Nuclear Criticality	-	-	-	-	-
Fire: a. Room b. Loading Dock	 1.0 0.01	 0.006 0.006	 0.01 0.01	 0.1 0.5	 Ground Ground
Spill: a. Room b. Glovebox c. Loading Dock	 1.0 1.0 0.25	 0.00002 0.00002 0.00008	 0.5 0.5 0.5	 2.0×10^{-6} 2.0×10^{-6} 0.1	 Elevated Elevated Ground
Earthquake	1.0	0.002 [f]	0.3 [f]	0.1	Ground
Aircraft Crash [g]	-	-	-	-	-

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Each drum with a plutonium content levelof 1,000 g.

[b] The wet criticality is not a viable accident scenario for this process.

[c] 3-day supply of feed and 2-day supply of product.

[d] 5 containers per drum of feed.

[e] 1 drum with a plutonium content level of 1,000 g.

[f] Add 0.000192 to all ARFxRF values for the resuspension of respirable particulates after the earthquake (e.g., ARFxRF + 0.000192 = 0.000792).

[g] Consequences enveloped by the earthquake.

Table D–190 Summary of the Sludge Residue (IDCs 089, 099, 332 excluded) Accident Doses for the Repackaging Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.0200	Metal	0.480	0.0520	8,400	200	5.60
Fire (Room)	0.00721	Metal	0.0173	0.00188	303	7.21	0.202
Fire (Dock)	0.00120	Metal	0.00288	0.000312	50.4	1.20	0.0336
Spill (Room)	5.00×10^{-9}	Metal	1.60×10^{-9}	6.00×10^{-15}	0.0000750	3.85×10^{-6}	9.50×10^{-10}
Spill (Glovebox)	3.34×10^{-9}	Metal	1.07×10^{-9}	4.01×10^{-10}	0.0000501	2.57×10^{-6}	6.35×10^{-10}
Spill (Dock)	0.00100	Metal	0.00240	0.000260	42.0	1.00	0.0280
Earthquake	0.0952	Metal	0.228	0.0248	4,000	95.2	2.67

MEI = maximally exposed individual Met = meteorological data

Table D–191 Summary of the Accident Analysis Risks in Terms of Latent Cancer Fatalities per year

Accident Scenario	*Accident Frequency (per year)*	*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.00005	1.20×10^{-8}	1.30×10^{-9}	0.000210	1.00×10^{-6}	1.12×10^{-7}
Fire (Room)	0.0005	4.33×10^{-9}	4.69×10^{-10}	0.0000757	1.80×10^{-6}	4.04×10^{-8}
Fire (Dock)	2.0×10^{-6}	2.88×10^{-12}	3.12×10^{-13}	5.04×10^{-8}	1.20×10^{-9}	2.69×10^{-11}
Spill (Room)	0.008	6.40×10^{-15}	2.40×10^{-15}	3.00×10^{-10}	1.54×10^{-11}	3.04×10^{-15}
Spill (Glovebox)	0.8	4.28×10^{-13}	1.60×10^{-13}	2.00×10^{-8}	1.03×10^{-9}	2.03×10^{-13}
Spill (Dock)	0.001	1.20×10^{-9}	1.30×10^{-10}	0.0000210	5.00×10^{-7}	1.12×10^{-8}
Earthquake	0.0026	2.97×10^{-7}	3.22×10^{-8}	0.00520	0.000124	2.77×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

Table D–192 Alternative 4 Accident Risks During Sludge Residue Processing

Sludge Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
IDCs 089, 099, 332	0.015	$4.72x10^{-9}$	$5.11x10^{-10}$	0.0000826	$1.97x10^{-6}$	$4.40x10^{-8}$
All other IDCs	0.20	1.02×10^{-8}	1.02×10^{-9}	0.000119	2.84×10^{-6}	6.37×10^{-8}
All sludge residues	0.22	1.42×10^{-8}	1.53×10^{-9}	0.000202	4.81×10^{-6}	1.08×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.7 Glass Residues

D.3.4.7.1 Alternative 1 – No Action

The glass residues processing technology considered for this alternative is the neutralization/dry process. This process will be conducted within glovebox lines at Rocky Flats in Building 371, Room 3701.

Table D–193 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of the neutralization/dry processing of glass residues. **Table D–194** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with this processing of glass residues. The risks associated with this processing technology are summarized in **Table D–195** and **Table D–196**.

Table D–193 Glass Residue Accident Scenario Parameters for the Neutralization/Dry Process at Rocky Flats

Accident Scenario	Frequency (per year)	Glass Residues	HEPA Banks	Material at Risk (grams)
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality	–	–	–	–
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [b] 4 drums [c]	 2 0	 2,646 g 6,000 g
Spill: a. Room [d] b. Glovebox c. Loading Dock	 – 0.80 0.001	 – 1 feed prep container 1 drum [e]	 – 2 0	 – 189 g 3,000 g
Earthquake	0.000094	5-day supply [b]	0	2,646 g
Aircraft Crash	0.00004	Consequences enveloped by the earthquake.	–	–

Accident Scenario	DR	ARF	RF	LPF	Release Point
Explosion	1.0	0.001	0.10	2.0×10^{-6}	Elevated
Nuclear Criticality [f]	–	–	–	–	–
Fire: a. Room b. Loading Dock	 1.0 0.01	 0.006 0.006	 0.01 0.01	 0.10 0.50	 Ground Ground

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [g]	1.0 [g]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [g]	1.0 [g]	0.10	Ground
Earthquake	1.0	0.002 [h]	0.30 [h]	0.10	Ground
Aircraft Crash [j]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] 3-day supply of feed and 2-day supply of product.

[c] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[d] Materials are opened in a glovebox. No room spill is considered.

[e] 1 drum at the maximum plutonium content level.

[f] The wet nuclear criticality is not a viable accident scenario for the neutralization/dry process in Building 371.

[g] The product of ARF×RF = 1.0×10^{-6}.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[j] Consequences enveloped by the earthquake.

Table D–194 Summary of the Glass Residue Accident Analysis Doses for the Neutralization/Dry Process at Rocky Flats

Accident Scenario	*Building Source Term (grams)*	*Type*	*MEI (rem) 95% Met*	*MEI (rem) 50% Met*	*Population (person-rem) 95% Met*	*Population (person-rem) 50% Met*	*Worker (rem) 50% Met*
Explosion	8.00×10^{-7}	Metal		2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.0159	Metal	0.0572	0.00572	667	15.9	0.445
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	3.78×10^{-10}	Metal	1.13×10^{-9}	1.29×10^{-10}	0.0000159	3.78×10^{-7}	9.45×10^{-10}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.0021
Earthquake	0.210	Metal	0.754	0.0754	8,800	210	5.87

MEI = maximally exposed individual Met = meteorological data

Table D–195 Summary of the Glass Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Neutralization/Dry Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr) 95% Met*	*MEI (LCF/yr) 50% Met*	*Population (LCF/yr) 95% Met*	*Population (LCF/yr) 50% Met*	*Worker (LCF/yr) 50% Met*
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	1.43×10^{-8}	1.43×10^{-9}	0.000167	3.97×10^{-6}	8.89×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	4.54×10^{-13}	5.14×10^{-14}	6.35×10^{-9}	1.51×10^{-10}	3.02×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	3.55×10^{-8}	3.55×10^{-9}	0.000414	9.85×10^{-6}	2.21×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–196 Alternative 1 Accident Risks During Glass Residue Processing

Glass Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
All Residues	0.037	1.85×10^{-9}	1.85×10^{-10}	0.0000215	5.13×10^{-7}	1.15×10^{-8}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.7.2 Alternative 2 – Processing without Plutonium Separation

The glass residues processing technologies considered for this alternative are calcination/vitrification, blend down, and sonic wash. The calcination/vitrification process will be performed at Rocky Flats in Building 707, Modules D, E, and F. The blend down and sonic wash processes will be performed at Rocky Flats in Building 371, Room 3701. Building 707 is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process.

Similar accidents are applicable to all of these technologies. **Table D–197** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of glass residues processing at Rocky Flats. **Table D–198** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of glass residues. The risks associated with these processing technologies are summarized in **Table D–199** and **Table D–200**.

Table D–197 Glass Residue Accident Scenario Parameters for theCalcination/ Vitrification Process, Blend Down Process, and Sonic Wash Process at Rocky Flats

Accident Scenario	Frequency (per year)	Glass Residues	HEPA Banks	Material at Risk (grams)		
				Calcination/ Vitrification Process [a]	Blend Down Process [b]	Sonic Wash Process [c]
Explosion	0.00005	2 drums [d]	0/2 [e]	4,000 g	4,000 g	4,000 g
Nuclear criticality [f]	–	–	–	–	–	–
Fire:						
a. Room	0.0005	5-day supply [g]	2	4,810 g feed + 3,206 g product [h]	7,014 g powder	1,588 g feed + 1,058 g product [h]
b. Loading Dock	2.0×10^{-6}	4 drums [j]	0	6,000 g	6,000 g	6,000 g
Spill:						
a. Room [k]	–	–	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	83.5 g	83.5 g	189 g
c. Loading Dock	0.001	1 drum [l]	0	3,000 g	3,000 g	3,000 g
Earthquake:						
a. Building 707	0.0026	5-day supply [g]	0	4,810 g feed + 3,206 g product [h]	7,014 g	N/A
b. Building 371	0.000094	5-day supply [g]	0	N/A	7,014 g	1,588 g feed + 1,058 g product [h]
Aircraft Crash:						
a. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–	–	N/A
b. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	N/A	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.1	1.0	Ground
b. Building 371	1.0	0.001	0.1	2.0×10^{-6}	Elevated
Nuclear criticality [f]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.1	Ground
b. Loading Dock	0.01	0.006	0.01	0.5	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [m]	1.0 [m]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [m]	1.0 [m]	0.10	Ground
Earthquake:					
a. Building 707	1.0	0.002 [n]	0.30 [n]	0.1	Ground
b. Building 371	1.0	0.002 [n]	0.30 [n]	0.1	Ground
Aircraft Crash:					
a. Building 707 [p]	–	–	–	–	–
b. Building 371 [q]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Building 707, Modules D, E, and F.

[b] Building 371, Room 3701, or Building 707.

[c] Building 371, Room 3701.

[d] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[e] Building 707, 0 HEPA Banks; Building 371, 2 HEPA Banks.

[f] The wet nuclear criticality is not a viable accident scenario for the calcination/vitrification, blend down, and sonic wash technology assessments.

[g] 3-day supply of feed and 2-day supply of product.

[h] The product is glass. The effect of the vitrified product on the accident source term is negligible.

[j] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[k] Materials are opened in a glovebox. No room spill is considered.

[l] 1 drum at the maximum plutonium content level.

[m] The product of ARF×RF = 1.0×10^{-6}.

[n] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[p] Consequences enveloped by the earthquake.

[q] The aircraft will not penetrate the building walls.

Table D–198 Summary of the Glass Residue Accident Analysis Doses for the Calcination/Vitrification Process, Blend Down Process, Sonic Wash Process at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0289	Metal	0.0693	0.00750	1,210	28.9	0.808
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.34×10^{-11}	2.00×10^{-11}	2.51×10^{-6}	1.29×10^{-7}	3.17×10^{-11}
Spill (Dock)	0.000075	Metal	0.00018	0.0000195	3.15	0.075	0.0021
Earthquake	0.381	Metal	0.914	0.099	16,000	381	10.7
Blend Down Process—Building 371							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.0421	Metal	0.152	0.0152	1,770	42.1	1.18

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.01×10^{-10}	5.68×10^{-11}	7.01×10^{-6}	1.67×10^{-7}	4.18×10^{-10}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.0021
Earthquake	0.556	Metal	2.00	0.200	23,300	556	15.6
Blend Down Process—Building 707							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0421	Metal	0.101	0.0109	1,770	42.1	1.18
Fire (Dock)	0.00180	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.34×10^{-11}	2.00×10^{-11}	2.51×10^{-6}	1.29×10^{-7}	3.17×10^{-11}
Spill (Dock)	0.000750	Metal	0.000180	0.0000195	3.15	0.0750	0.00210
Earthquake	0.556	Metal	1.33	0.144	23,300	556	15.6
Sonic Wash Process							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.00953	Metal	0.0343	0.00343	400	9.53	0.267
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	3.78×10^{-10}	Metal	1.13×10^{-9}	1.29×10^{-10}	0.0000159	3.78×10^{-7}	9.45×10^{-10}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.00210
Earthquake	0.126	Metal	0.453	0.0453	5,280	126	3.52

MEI = maximally exposed individual Met = meteorological data

Table D–199 Summary of the Glass Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Calcination/Vitrification Process, Blend Down Process, Sonic Wash Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	1.73×10^{-8}	1.88×10^{-9}	0.000303	7.21×10^{-6}	1.62×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	2.14×10^{-14}	8.02×10^{-15}	1.00×10^{-9}	5.14×10^{-11}	1.02×10^{-14}
Spill (Dock)	0.001	9.00×10^{-11}	9.75×10^{-12}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.0026	1.19×10^{-6}	1.29×10^{-7}	0.0208	0.000495	0.0000111
Blend Down Process—Building 371						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	3.79×10^{-8}	3.79×10^{-9}	0.000442	0.0000105	2.36×10^{-7}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	2.00×10^{-13}	2.27×10^{-14}	2.81×10^{-9}	6.68×10^{-11}	1.34×10^{-13}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	9.40×10^{-8}	9.40×10^{-9}	0.0011	0.0000261	5.85×10^{-7}
Blend Down Process—Building 707						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.000420	0.0000100	2.24×10^{-7}
Fire (Room)	0.0005	2.53×10^{-8}	2.74×10^{-9}	0.000442	0.0000105	2.36×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.8	2.14×10^{-14}	8.02×10^{-15}	1.00×10^{-9}	5.14×10^{-11}	1.02×10^{-14}
Spill (Dock)	0.001	9.00×10^{-11}	9.75×10^{-12}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-14}
Earthquake	0.0026	1.73×10^{-6}	1.88×10^{-7}	0.0303	0.000722	0.0000162
Sonic Wash Process						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	8.58×10^{-9}	8.58×10^{-10}	0.0001	2.38×10^{-6}	5.34×10^{-8}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	4.54×10^{-13}	5.14×10^{-14}	6.35×10^{-9}	1.51×10^{-10}	3.02×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	2.13×10^{-8}	2.13×10^{-9}	0.000248	5.91×10^{-6}	1.32×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–200 Alternative 2 Accident Risks During Glass Residue Processing

Glass Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Calcination/Vitrification Process						
All Residues	0.012	1.48×10^{-8}	1.60×10^{-9}	0.000258	6.15×10^{-6}	1.38×10^{-7}
Blend Down Process – Building 371						
All Residues	0.014	1.85×10^{-9}	1.85×10^{-10}	0.0000216	5.13×10^{-7}	1.15×10^{-8}
Blend Down Process – Building 707						
All Residues	0.014	2.50×10^{-8}	2.70×10^{-9}	0.000437	0.0000104	2.33×10^{-7}
Sonic Wash Process						
All Residues	0.037	1.11×10^{-9}	1.11×10^{-10}	0.0000129	3.08×10^{-7}	6.91×10^{-9}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.7.3 Alternative 3 – Processing with Plutonium Separation

The glass residues processing technology considered for this alternative is mediated electrochemical oxidation. Most of the mediated electrochemical oxidation process will be performed at Rocky Flats in Building 371, Room 3701. The final calcination in the process will be performed at Rocky Flats in Building 707A, Module J.

Similar accidents are applicable to the mediated electrochemical oxidation processes in both buildings. **Table D–201** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of processing glass residues using the mediated electrochemical oxidation technology at Rocky Flats. **Table D–202** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of glass residues. The risks associated with this processing technology are summarized in **Table D–203** and **Table D–204**.

Table D–201 Glass Residue Accident Scenario Parameters for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	Frequency (per year)	Glass Residues	HEPA Banks	Material at Risk (grams)	
				MEO Process	
				Building 371	Building 707A
Explosion (Acetylene)	0.00005	2 drums	2/0 [a]	4,000 g [b]	1,960 g [c]
Explosion (Ion Exchange Column)	0.0001	Solution	2	0.245 mg [d]	N/A
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	N/A [e]
Fire:					
a. Room	0.0005	5-day supply [f]	2	5,180 g	14,700 g
b. Loading Dock	2.0×10^{-6}	4 drums	0	6,000 g [g]	3,920 g [c]
Spill:					
a. Room [h]	–	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	200 g	980 g
c. Loading Dock	0.001	1 drum	0	3,000 g [j]	980 g [c]
Earthquake:					
a. Building 371	0.000094	5-day supply [f]	0	5,180 g	N/A
b. Building 707A	0.0026	5-day supply [f]	0	N/A	14,700 g

Accident Scenario	Frequency (per year)	Glass Residues	HEPA Banks	Material at Risk (grams) MEO Process Building 371	Material at Risk (grams) MEO Process Building 707A
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	–

Accident Scenario	DR	ARF	RF	LPF	Release Point
Explosion (Acetylene):					
a. Building 707A	1.0	0.001	0.1	1.0	Ground
b. Building 371	1.0	0.001	0.1	2.0×10^{-6}	Elevated
Explosion (Ion Exchange Column) [d]	1.0	1.0	1.0	1.0	Elevated
Nuclear Criticality [e, k]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [l]	1.0 [l]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [l]	1.0 [l]	0.10	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.002 [m]	0.30 [m]	0.10	Ground
Aircraft Crash:					
a. Building 707A [n]	–	–	–	–	–
b. Building 371 [p]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.

[b] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[c] 980-g product containers are transported from Building 371 to Building 707A for processing.

[d] Respirable source term value in milligrams of plutonium released up the stack.

[e] The wet nuclear criticality is not a viable accident scenario for the mediated electrochemical oxidation process in Building 707A.

[f] 3-day supply of feed and 2-day supply of product.

[g] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[h] Materials are opened in a glovebox. No room spill is considered.

[j] 1 drum at the maximum plutonium content level.

[k] Refer to Table D–28 for Building 371 mediated electrochemical oxidation criticality accident source term.

[l] The product of ARF×RF = 1.0×10^{-6}.

[m] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[n] Consequences enveloped by the earthquake.

[p] The aircraft will not penetrate the building walls.

Table D–202 Summary of the Glass Residue Accident Analysis Doses for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Building 371							
Explosion (Acetylene)	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Explosion (Ion Exchange Column)	0.000245	Metal	0.000735	0.0000833	10.3	0.245	0.000613
Criticality (Liquid)	[a]	–	0.790	0.110	6,980	252	0.321

Accident Scenario	Building Source Term (grams)	Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Fire (Room)	0.0311	Metal	0.112	0.0112	1,310	31.1	0.870
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	4.00×10^{-10}	Metal	1.20×10^{-9}	1.36×10^{-10}	0.0000168	4.00×10^{-7}	1.00×10^{-9}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.0021
Earthquake	0.410	Metal	1.48	0.148	17,200	410	11.5
Building 707A							
Explosion (Acetylene)	0.196	Oxide	0.235	0.0255	4,900	118	4.12
Fire (Room)	0.0882	Oxide	0.106	0.0115	2,210	52.9	1.85
Fire (Dock)	0.00118	Oxide	0.00141	0.000153	29.4	0.706	0.0247
Spill (Glovebox)	1.96×10^{-9}	Oxide	3.14×10^{-10}	1.18×10^{-10}	0.0000171	8.82×10^{-7}	2.74×10^{-10}
Spill (Dock)	0.0000245	Oxide	0.0000294	3.19×10^{-6}	0.613	0.0147	0.000515
Earthquake	1.16	Oxide	1.40	0.151	29,100	699	24.4

MEI = maximally exposed individual Met = meteorological data
[a] 1.0×10^{19} fissions.

Table D–203 Summary of the Glass Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Building 371						
Explosion (Acetylene)	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Explosion (Ion Exchange Column)	0.0001	3.68×10^{-11}	4.17×10^{-12}	5.15×10^{-7}	1.23×10^{-8}	2.45×10^{-11}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	2.80×10^{-8}	2.80×10^{-9}	0.000326	7.77×10^{-6}	1.74×10^{-7}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	4.80×10^{-13}	5.44×10^{-14}	6.72×10^{-9}	1.60×10^{-10}	3.20×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	6.94×10^{-8}	6.94×10^{-9}	0.00081	0.0000193	4.32×10^{-7}
Building 707A						
Explosion (Acetylene)	0.00005	5.88×10^{-9}	6.37×10^{-10}	0.000123	2.94×10^{-6}	8.23×10^{-8}
Fire (Room)	0.0005	2.65×10^{-8}	2.87×10^{-9}	0.000551	0.0000132	3.70×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.41×10^{-12}	1.53×10^{-13}	2.94×10^{-8}	7.06×10^{-10}	1.98×10^{-11}
Spill (Glovebox)	0.80	1.25×10^{-13}	4.70×10^{-14}	6.82×10^{-9}	3.53×10^{-10}	8.78×10^{-14}
Spill (Dock)	0.001	1.47×10^{-11}	1.59×10^{-12}	3.06×10^{-7}	7.35×10^{-9}	2.06×10^{-10}
Earthquake	0.0026	1.82×10^{-6}	1.97×10^{-7}	0.0378	0.000908	0.0000509

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–204 Alternative 3 Accident Risks During Mediated Electrochemical Oxidation Processing at Rocky Flats

Glass Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Building 371						
All Residues	0.019	2.60×10^{-9}	2.90×10^{-10}	0.0000283	7.54×10^{-7}	1.18×10^{-8}
Building 707A						
All Residues	0.0064	1.18×10^{-8}	1.28×10^{-9}	0.000246	5.92×10^{-6}	3.28×10^{-7}
Buildings 371 and 707A						
All Residues	–	1.44×10^{-8}	1.57×10^{-9}	0.000275	6.67×10^{-6}	3.40×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.7.4 Alternative 4 – Combination of Processing Technologies

The glass residue processing technology considered for this alternative is the neutralization/dry process. All glass residue can be processed using this technology. The neutralization/dry process technology accident descriptions, consequences and risks are identical to those presented in Section D.3.4.7.1, Alternative 1 - No Action. Refer to Section D.3.4.7.1 for details.

D.3.4.8 Graphite Residues

D.3.4.8.1 Alternative 1 – No Action

The graphite residues processing technology considered for this alternative is repackaging. Repackaging of residues will be conducted within glovebox lines in Modules D, E, and F in Building 707 at Rocky Flats.

Table D–205 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of repackaging graphite residues at Rocky Flats. **Table D–206** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the repackaging of graphite residues at Rocky Flats. The risks associated with this processing technology are summarized in **Table D–207** and **Table D–208**.

Table D–205 Graphite Residue Accident Scenario Parameters for Repackaging at Rocky Flats

Accident Scenario	Frequency (per year)	Graphite Residues	HEPA Banks	Material at Risk (grams)
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [b]	2	8,016 g
b. Loading Dock	2.0×10^{-6}	4 drums [c]	0	6,000 g

Accident Scenario	*Frequency (per year)*	*Graphite Residues*	*HEPA Banks*	*Material at Risk (grams)*
Spill:				
a. Room	0.008	1 container at the maximum limit [d]	2	600 g
b. Glovebox	0.80	1 feed prep container	2	83.5 g
c. Loading Dock	0.001	1 drum [e]	0	3,000 g
Earthquake	0.0026	5-day supply [b]	0	8,016 g
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.10	1.0	Ground
Nuclear Criticality [f]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Room	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake	1.0	0.002 [g]	0.30 [g]	0.10	Ground
Aircraft Crash [h]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content

[b] 3-day supply of feed and 2-day supply of product.

[c] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[d] 5 containers per drum of feed.

[e] 1 drum at the maximum plutonium content level.

[f] The wet nuclear criticality is not a viable accident scenario for the repackaging process in Building 707.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] Consequences enveloped by the earthquake.

Table D–206 Summary of the Graphite Residue Accident Analysis Doses for Repackaging at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0481	Metal	0.115	0.0125	2,020	48.1	1.35
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.84×10^{-9}	1.44×10^{-9}	0.00018	9.24×10^{-6}	2.28×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.34×10^{-10}	2.00×10^{-10}	0.0000251	1.29×10^{-6}	3.17×10^{-10}

Accident Scenario	Building Source Term		MEI (rem)		Population (person-rem)		Worker (rem)
	(grams)	Type	95% Met	50% Met	95% Met	50% Met	50% Met
Spill (Dock)	0.003	Metal	0.0072	0.00078	126	3.00	0.084
Earthquake	0.635	Metal	1.52	0.165	26,700	635	17.8

MEI = maximally exposed individual Met = meteorological data

Table D–207 Summary of the Graphite Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for Repackaging at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	2.89×10^{-8}	3.13×10^{-9}	0.000505	1.20×10^{-6}	2.69×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.54×10^{-14}	5.76×10^{-15}	7.20×10^{-10}	3.70×10^{-11}	7.30×10^{-15}
Spill (Glovebox)	0.80	2.14×10^{-13}	8.02×10^{-14}	1.00×10^{-8}	5.14×10^{-10}	1.02×10^{-13}
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	1.98×10^{-6}	2.15×10^{-7}	0.0347	0.000825	0.0000185

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–208 Alternative 1 Accident Risks During Graphite Residue Processing

Graphite Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
All Residues	0.23	4.69×10^{-7}	5.08×10^{-8}	0.0082	0.000195	4.37×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.8.2 Alternative 2 – Processing without Plutonium Separation

The graphite residues processing technologies considered for this alternative are calcination/vitrification, blend down, and cementation. The calcination/vitrification process will be performed at Rocky Flats in Building 707, Modules D, E, and F. The blend down process will be performed at Rocky Flats in Building 707, Module E. Building 371 is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process. The cementation process will be performed at Rocky Flats in Building 371, Room 3701. Building 707 is under consideration as an alternate location for the cementation process. The accident analysis evaluates both the primary and alternate locations for the cementation process.

Similar accidents are applicable to all of these technologies. **Table D–209** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of graphite residues processing at Rocky Flats. **Table D–210** summarizes the consequences to the maximally exposed individual, the public, and workers

resulting from the accidental releases associated with the processing of graphite residues. The risks associated with these processing technologies are summarized in **Table D–211** and **Table D–212**.

Table D–209 Graphite Residue Accident Scenario Parameters for the Calcination/Vitrification Process, Blend Down Process, and Cementation Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Graphite Residues*	*HEPA Banks*	*Material at Risk (grams)*		
				Calcination/ Vitrification Process [a]	*Blend Down Process* [b]	*Cementation Process* [c]
Explosion	0.00005	2 drums [d]	0/2 [e]	4,000 g	4,000 g	4,000 g
Nuclear Criticality [f]	–	–	–	–	–	–
Fire:						
a. Room	0.0005	5-day supply [g]	2	4,810 g feed + 3,206 g product [h]	8,016 g	3,507 g feed + 2,338 g product [j]
b. Loading Dock	2.0×10^{-6}	4 drums [k]	0	6,000 g	6,000 g	6,000 g
Spill:						
a. Room	0.008	1 container at the maximum limit [l]	2	600 g	600 g	600 g
b. Glovebox	0.8	1 feed prep container	2	83.5 g	83.5g	83.5g
c. Loading Dock	0.001	1 drum [m]	0	3,000 g	3,000 g	3,000 g
Earthquake:						
a. Building 707	0.0026	5-day supply [g]	0	4,810 g feed + 3,206 g product [h]	8,016 g	3,507 g feed + 2,338 g product [j]
b. Building 371	0.000094	5-day supply [g]	0	N/A	8,016 g	3,507 g feed + 2,338 g product [j]
Aircraft Crash:						
a. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–	–	–
b. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	N/A	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.10	1.0	Ground
b. Building 371	1.0	0.001	0.10	2.0×10^{-6}	Elevated
Nuclear Criticality [f]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Room	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake:					
Buildings 371 and 707	1.0	0.002 [n]	0.30 [n]	0.10	Ground
Aircraft Crash:					
a. Building 707 [p]	–	–	–	–	–
b. Building 371 [q]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Building 707, Modules D, E, and F.

[b] Building 707, Module E, or Building 371.

[c] Building 371, Room 3701, or Building 707.

[d] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[e] Building 707, 0 HEPA Banks; Building 371, 2 HEPA Banks.

[f] The wet nuclear criticality is not a viable accident scenario for the calcination/vitrification, blend down, and sonic wash technology assessments.

[g] 3-day supply of feed and 2-day supply of product.
[h] The product is glass. The effect of the vitrified product on the accident source term is negligible.
[j] The product is concrete. The effect of the residue immobilized in the concrete on the accident source term is negligible.
[k] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[l] 5 containers per drum of feed.
[m] 1 drum at the maximum plutonium content level.
[n] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[p] Consequences enveloped by the earthquake.
[q] The aircraft will not penetrate the building walls.

Table D–210 Summary of the Graphite Residue Accident Analysis Doses for the Calcination/Vitrification Process, Blend Down Process, and Cementation Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Calcination/Vitrification Process							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0289	Metal	0.0693	0.0075	1,210	28.9	0.808
Fire (Dock)	0.00180	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.84×10^{-9}	1.44×10^{-9}	0.00018	9.24×10^{-6}	2.28×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.34×10^{-10}	2.00×10^{-10}	0.0000251	1.29×10^{-6}	3.17×10^{-10}
Spill (Dock)	0.003	Metal	0.0072	0.00078	126	3.00	0.084
Earthquake	0.381	Metal	0.914	0.099	16,000	381	10.7
Blend Down Process—Building 707							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0481	Metal	0.115	0.0125	2,020	48.1	1.35
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.84×10^{-9}	1.44×10^{-9}	0.00018	9.24×10^{-6}	2.28×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.34×10^{-10}	2.00×10^{-10}	0.0000251	1.29×10^{-6}	3.17×10^{-10}
Spill (Dock)	0.003	Metal	0.0072	0.00078	126	3.00	0.084
Earthquake	0.635	Metal	1.52	0.165	26,700	635	17.8
Blend Down Process—Building 371							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.000800	2.00×10^{-6}
Fire (Room)	0.0481	Metal	0.173	0.0173	2,020	48.1	1.35
Fire (Dock)	0.00180	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.0000120	3.00×10^{-8}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.01×10^{-9}	5.68×10^{-10}	0.0000701	1.67×10^{-6}	4.18×10^{-9}
Spill (Dock)	0.00300	Metal	0.0108	0.00108	126	3.00	0.0840
Earthquake	0.635	Metal	2.29	0.229	26,700	635	17.8
Cementation Process—Building 371							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Fire (Room)	0.021	Metal	0.0758	0.00758	884	21.0	0.589
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.08	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.000012	3.00×10^{-8}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.01×10^{-9}	5.68×10^{-10}	0.0000701	1.67×10^{-6}	4.18×10^{-9}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	0.278	Metal	1.00	0.100	11,700	278	7.78
Cementation Process—Building 707							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0210	Metal	0.0505	0.00547	884	21.0	0.589
Fire (Dock)	0.00180	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.84×10^{-9}	1.44×10^{-9}	0.000180	9.24×10^{-6}	2.28×10^{-9}
Spill (Glovebox)	1.67×10^{-9}	Metal	5.34×10^{-10}	2.00×10^{-10}	0.0000251	1.29×10^{-6}	3.17×10^{-10}
Spill (Dock)	0.00300	Metal	0.00720	0.000780	126	3.00	0.0840
Earthquake	0.278	Metal	0.667	0.0722	11,700	278	7.78

MEI = maximally exposed individual Met = meteorological data

Table D–211 Summary of the Graphite Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Calcination/Vitrification Process, Blend Down Process, and Cementation Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Calcination/Vitrification Process						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	1.73×10^{-8}	1.88×10^{-9}	0.000303	7.22×10^{-6}	1.62×10^{-7}
Fire (Dock)	2.00×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.54×10^{-14}	5.76×10^{-15}	7.20×10^{-10}	3.70×10^{-11}	7.30×10^{-15}
Spill (Glovebox)	0.800	2.14×10^{-13}	8.02×10^{-14}	1.00×10^{-8}	5.14×10^{-10}	1.02×10^{-13}
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	1.19×10^{-6}	1.29×10^{-7}	0.0208	0.000495	0.0000111
Blend Down Process—Building 707						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	2.89×10^{-8}	3.13×10^{-9}	0.000505	0.000012	2.69×10^{-7}
Fire (Dock)	2.00×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.54×10^{-14}	5.76×10^{-15}	7.20×10^{-10}	3.70×10^{-11}	7.30×10^{-15}
Spill (Glovebox)	0.800	2.14×10^{-13}	8.02×10^{-14}	1.00×10^{-8}	5.14×10^{-10}	1.02×10^{-13}

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	1.98×10^{-6}	2.15×10^{-7}	0.0347	0.000825	0.0000185
Blend Down Process—Building 371						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	4.33×10^{-8}	4.33×10^{-9}	0.000505	0.0000120	2.69×10^{-7}
Fire (Dock)	2.00×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}
Spill (Glovebox)	0.8	2.00×10^{-12}	2.27×10^{-13}	2.81×10^{-8}	6.68×10^{-10}	1.34×10^{-12}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.0000630	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	1.07×10^{-7}	1.07×10^{-8}	0.00125	0.0000298	6.68×10^{-7}
Cementation Process—Building 371						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	1.89×10^{-8}	1.89×10^{-9}	0.000221	5.26×10^{-6}	1.18×10^{-7}
Fire (Dock)	2.00×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}
Spill (Glovebox)	0.800	2.00×10^{-13}	2.27×10^{-13}	2.81×10^{-8}	6.68×10^{-10}	1.34×10^{-12}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	4.70×10^{-8}	4.70×10^{-9}	0.000548	0.0000131	2.92×10^{-7}
Cementation Process—Building 707						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.000420	0.0000100	2.24×10^{-7}
Fire (Room)	0.0005	1.26×10^{-8}	1.37×10^{-9}	0.000221	5.26×10^{-6}	1.18×10^{-7}
Fire (Dock)	2.00×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.54×10^{-14}	5.76×10^{-15}	7.20×10^{-10}	3.70×10^{-11}	7.30×10^{-15}
Spill (Glovebox)	0.8	2.14×10^{-13}	8.02×10^{-14}	1.00×10^{-8}	5.14×10^{-10}	1.02×10^{-13}
Spill (Dock)	0.001	3.60×10^{-9}	3.90×10^{-10}	0.0000630	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.0026	8.67×10^{-7}	9.39×10^{-8}	0.0152	0.000361	8.09×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–212 Alternative 2 Accident Risks During Graphite Residue Processing

Graphite Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Calcination/Vitrification Process						
All Residues	0.23	2.84×10^{-7}	3.07×10^{-8}	0.00496	0.000118	2.65×10^{-6}
Blend Down Process – Building 707						
All Residues	0.23	4.69×10^{-7}	5.08×10^{-8}	0.0082	0.000195	4.37×10^{-6}

Graphite Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Blend Down Process – Building 371						
All Residues	0.23	3.59×10^{-8}	3.59×10^{-9}	0.000419	9.97×10^{-6}	2.23×10^{-7}
Cementation Process – Building 371						
All Residues	0.32	2.28×10^{-8}	2.28×10^{-9}	0.000266	6.34×10^{-6}	1.42×10^{-7}
Cementation Process – Building 707						
All Residues	0.32	2.90×10^{-7}	3.14×10^{-8}	0.00508	0.000121	2.71×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.8.3 Alternative 3 – Processing with Plutonium Separation

The graphite residues processing technology considered for this alternative is mediated electrochemical oxidation. Processing of graphite residues with the mediated electrochemical oxidation process may be performed at either Rocky Flats or the Savannah River Site. At Rocky Flats, most of the mediated electrochemical oxidation process will be performed in Building 371, Room 3701; the final calcination in the process will be performed in Building 707A, Module J. For processing at the Savannah River Site, the packaging of the residues at Rocky Flats will be performed in Building 371, Room 371. The mediated electrochemical oxidation process will be performed in the canyon facilities at the Savannah River Site.

Similar accidents are applicable to the mediated electrochemical oxidation processes at both sites. **Table D–213** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of graphite residues processing using the mediated electrochemical oxidation technology at Rocky Flats. **Table D–214** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of graphite residues at Rocky Flats. The risks associated with this processing technology at Rocky Flats are summarized in **Table D–215** and **Table D–216**.

Table D–213 Graphite Residue Accident Scenario Parameter for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	Frequency (per year)	Graphite Residues	HEPA Banks	Material at Risk (grams)	
				Mediated Electrochemical Oxidation Process	
				Building 371	Building 707A [a]
Explosion (Acetylene)	0.00005	2 drums	2/0 [b]	4,000 g [c]	2,000 g
Explosion (Ion Exchange Column)	0.0001	Solution	2	0.245 mg [d]	N/A
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	N/A [e]
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [f] 4 drums	 2 0	 5,550 g 6,000 g [g]	 6,000 g 4,000 g

Accident Scenario	*Frequency (per year)*	*Graphite Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Mediated Electrochemical Oxidation Process	
				Building 371	*Building 707A* [a]
Spill:					
a. Room	0.008	1 container at the maximum limit [h]	2	600 g	N/A [j]
b. Glovebox	0.80	1 feed prep container	2	200 g	1,000 g
c. Loading Dock	0.001	1 drum	0	3,000 g [k]	1,000 g
Earthquake:					
a. Building 371	0.000094	5-day supply [f]	0	5,550 g	N/A
b. Building 707A	0.0026	5-day supply [f]	0	N/A	6,000 g
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion (Acetylene):					
a. Building 707A	1.0	0.001	0.10	1.0	Ground
b. Building 371	1.0	0.001	0.10	2.0×10^{-6}	Elevated
Explosion (Ion Exchange Column) [d]	1.0	1.0	1.0	1.0	Elevated
Nuclear Criticality [e, l]	–	–	–	–	Elevated
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Room [j]	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.002 [m]	0.30 [m]	0.10	Ground
Aircraft Crash:					
a. Building 707A [n]	–	–	–	–	–
b. Building 371 [p]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1,000-g product container transported from Building 371 to Building 707A for processing.

[b] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.

[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[d] Respirable source term value in milligrams of plutonium released up the stack.

[e] The wet nuclear criticality is not a viable accident scenario for the mediated electrochemical oxidation process in Building 707A.

[f] 3-day supply of feed and 2-day supply of product.

[g] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[h] 5 containers per drum of feed.

[j] Materials are opened in a glovebox in Building 707A. No room spill is considered.

[k] 1 drum at the maximum plutonium content level.

[l] Refer to Table D–28 for Building 371 mediated electrochemical oxidation criticality accident source term.
[m] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).
[n] Consequences enveloped by the earthquake.
[p] The aircraft will not penetrate the building walls.

Table D–214 Summary of the Graphite Residue Accident Analysis Doses for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Building 371							
Explosion (Acetylene)	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Explosion (Ion Exchange Column)	0.000245	Metal	0.000735	0.0000833	10.3	0.245	0.000613
Criticality (Liquid)	[a]	–	0.790	0.110	6,980	252	0.321
Fire (Room)	0.0333	Metal	0.120	0.012	1,400	33.3	0.932
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.000012	3.00×10^{-8}
Spill (Glovebox)	4.00×10^{-9}	Metal	1.20×10^{-8}	1.36×10^{-9}	0.000168	4.00×10^{-6}	1.00×10^{-8}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	0.440	Metal	1.58	0.158	18,500	440	12.3
Building 707A							
Explosion (Acetylene)	0.200	Oxide	0.240	0.026	5,000	120	4.20
Fire (Room)	0.036	Oxide	0.0432	0.00468	900	21.6	0.756
Fire (Dock)	0.0012	Oxide	0.00144	0.000156	30.0	0.720	0.0252
Spill (Glovebox)	2.00×10^{-8}	Oxide	3.20×10^{-9}	1.20×10^{-9}	0.000174	9.00×10^{-6}	2.80×10^{-9}
Spill (Dock)	0.001	Oxide	0.0012	0.00013	25.0	0.600	0.021
Earthquake	0.475	Oxide	0.570	0.0618	11,900	285	9.98

MEI = maximally exposed individual Met = meteorological data

[a] 1.0×10^{19} fissions.

Table D–215 Summary of the Graphite Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Building 371						
Explosion (Acetylene)	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Explosion (Ion Exchange Column)	0.0001	3.68×10^{-11}	4.17×10^{-12}	5.15×10^{-7}	1.23×10^{-8}	2.45×10^{-11}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	3.00×10^{-8}	3.00×10^{-9}	0.00035	8.33×10^{-6}	1.86×10^{-7}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}
Spill (Glovebox)	0.80	4.80×10^{-12}	5.44×10^{-13}	6.72×10^{-8}	1.60×10^{-9}	3.20×10^{-12}

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	7.44×10^{-8}	7.44×10^{-9}	0.000868	0.0000207	4.63×10^{-7}
Building 707A						
Explosion (Acetylene)	0.00005	6.00×10^{-9}	6.50×10^{-10}	0.000125	3.00×10^{-6}	8.40×10^{-8}
Fire (Room)	0.0005	1.08×10^{-8}	1.17×10^{-9}	0.000225	5.40×10^{-6}	1.51×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.44×10^{-12}	1.56×10^{-13}	3.00×10^{-8}	7.20×10^{-10}	2.02×10^{-11}
Spill (Glovebox)	0.80	1.28×10^{-12}	4.80×10^{-13}	6.96×10^{-8}	3.60×10^{-9}	8.96×10^{-13}
Spill (Dock)	0.001	6.00×10^{-10}	6.50×10^{-11}	0.0000125	3.00×10^{-7}	8.40×10^{-9}
Earthquake	0.0026	7.41×10^{-7}	8.03×10^{-8}	0.0154	0.000371	0.0000104

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–216 Alternative 3 Accident Risks During Mediated Electrochemical Oxidation Processing at Rocky Flats

Graphite Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371						
All Residues	0.33	4.93×10^{-8}	5.44×10^{-9}	0.000538	0.0000142	$2.30\times^{-7}$
Building 707A						
All Residues	0.31	2.35×10^{-7}	2.55×10^{-8}	0.0049	0.000118	3.29×10^{-6}
Buildings 371 and 707A						
All Residues	–	2.84×10^{-7}	3.09×10^{-8}	0.00544	0.000132	3.52×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

Table D–217 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of packaging the graphite residues at Rocky Flats and of processing the residues using the mediated electrochemical oxidation technology at the Savannah River Site. **Table D–218** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with packaging the graphite residues at Rocky Flats and processing the graphite residues at the Savannah River Site. The risks associated with packaging at Rocky Flats and using the mediated electrochemical oxidation process at the Savannah River Site are summarized in **Table D–219** and **Table D–220**. The processes at the Savannah River Site could be performed in either the F-Canyon and FB-Line or the H-Canyon and HB-Line. Data are presented in Table D–217, Table D–218, Table d-219 and Table D–220 for both options.

Table D–217 Graphite Residue Accident Scenario Parameters for the Mediated Electrochemical Oxidation Process at the Savannah River Site

Accident Scenario	*Frequency (per year)*	*Graphite Residues*	*HEPA Banks*	*Material at Risk (grams)*
Rocky Flats Packaging of Residue for Shipment to the Savannah River Site				
Explosion	0.00005	2 drums [a]	2	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [c]	2	8,652 g
b. Loading Dock	2.0×10^{-6}	4 drums [d]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the maximum limit [e]	2	600 g
b. Glovebox	0.80	1 feed prep container	2	103 g
c. Loading Dock	0.001	1 drum [f]	0	3,000 g
Earthquake	0.000094	5-day supply [c]	0	8,652 g
Aircraft Crash	0.00004	The aircraft will not penetrate the building wall.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.10	2.0×10^{-6}	Elevated
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Room	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
b. Glovebox	1.0	0.00002	0.50	2.0×10^{-6}	Elevated
c. Loading Dock	0.25	0.00008	0.50	0.10	Ground
Earthquake	1.0	0.002 [g]	0.30 [g]	0.10	Ground
Aircraft Crash [h]	–	–	–	–	–

Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon		
Accident Scenario	*Frequency (per year)*	*Material at Risk (grams)*
Explosion:		
a. Hydrogen	0.000015	4,000 g
b. Ion Exchange column	0.0001	120.5 mg [j]
Nuclear Criticality [k]	0.0001	1.0×10^{19} fissions
Fire	0.00061	4,000 g
Spill	0.01	103 g
Earthquake:	0.000125	
a. F-Canyon		
Liquid		12,000 g
b. FB-Line		
Powder		1,000 g
Metal		1,000 g
Liquid		1,000 g

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Explosion:				
a. Hydrogen	1.0	0.001	0.005	Elevated
b. Ion Exchange Column	1.0	1.0	1.0	Elevated
Nuclear Criticality [k]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill	1.0	0.00001	0.005	Elevated

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Earthquake:				
a. F-Canyon				
Liquid	1.0	0.000047	0.10	Ground
b. FB-Line				
Powder	1.0	0.002	0.10	Ground
Metal	1.0	0.0022	0.10	Ground
Liquid	1.0	0.000047	0.10	Ground

Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon		
Accident Scenario	*Frequency (per year)*	*Material at Risk (grams)*
Explosion:		
a. Hydrogen	0.000015	4,000 g
b. Ion Exchange column	0.0001	241 mg [j, l]
Nuclear Criticality [k]	0.0001	1.0×10^{19} fissions
Fire	0.00061	6,000 g
Spill	0.01	103 g
Earthquake:	0.000182	
a. H-Canyon		
Liquid		27,000 g
b. HB-Line		
Powder		4,000 m
Liquid		4,000 m

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Explosion:				
a. Hydrogen	1.0	0.001	0.005	Elevated
b. Ion Exchange Column	1.0	1.0	1.0	Elevated
Nuclear Criticality [k]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill	1.0	0.00001	0.005	Elevated
Earthquake:				
a. H-Canyon	1.0	0.000047	0.10	Ground
b. HB-Line Powder	1.0	0.002	0.10	Ground
HB-Line Liquid	1.0	0.000047	0.10	Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the residue packaging process in Building 371.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 5 containers per drum of feed.

[f] 1 drum at the maximum plutonium content level.

[g] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000792).

[h] The aircraft will not penetrate the building walls.

[j] Respirable source term value in milligrams of plutonium released up the stack.

[k] Refer to Table D–28 for criticality accident source term.

[l] Duty cycle = 60%.

Table D–218 Summary of the Graphite Residue Accident Analysis Doses for the Mediated Electrochemical Oxidation Process at the Savannah River Site

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Rocky Flats Packaging of Residue for Shipment to the Savannah River Site							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.0519	Metal	0.187	0.0187	2,180	51.9	1.45
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Room)	1.20×10^{-8}	Metal	3.60×10^{-8}	4.08×10^{-9}	0.000504	0.000012	3.00×10^{-8}
Spill (Glovebox)	2.06×10^{-9}	Metal	6.18×10^{-9}	7.00×10^{-10}	0.0000865	2.06×10^{-6}	5.15×10^{-9}
Spill (Dock)	0.003	Metal	0.0108	0.00108	126	3.00	0.084
Earthquake	0.685	Metal	2.47	0.247	28,800	685	19.2
Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon							
Explosion (Hydrogen)	0.02	Metal	0.00068	0.00024	36.0	3.20	0.002
Explosion (Ion Exchange Column)	0.121	Metal-FB	0.00374	0.00133	193	18.1	0.0112
Criticality (Liquid)	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.200	Metal	0.0068	0.0024	360	32.0	0.02
Spill	5.15×10^{-6}	Metal	1.75×10^{-7}	6.18×10^{-8}	0.00927	0.000824	5.15×10^{-7}
Earthquake	0.481	Metal	0.0443	0.00818	1,590	111	10.6
Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon							
Explosion (Hydrogen)	0.02	Metal	0.00064	0.000192	32.0	3.00	0.002
Explosion (Ion Exchange Column)	0.241	Metal-HB	0.00699	0.00212	342	34.0	0.0224
Criticality (Liquid)	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.300	Metal	0.0096	0.00288	480	45.0	0.03
Spill	5.15×10^{-6}	Metal	1.65×10^{-7}	4.94×10^{-8}	0.00824	0.000773	5.15×10^{-7}
Earthquake	0.946	Metal	0.0653	0.0132	2,930	189	20.8

MEI = maximally exposed individual Met = meteorological data

[a] 1.0×10^{19} fissions.

Table D–219 Summary of the Graphite Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Mediated Electrochemical Oxidation Process at the Savannah River Site

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Rocky Flats Packaging of Residue for Shipment to the Savannah River Site						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	4.67×10^{-8}	4.67×10^{-9}	0.000545	0.000013	2.91×10^{-7}
Fire (Dock)	2.00×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Room)	0.008	1.44×10^{-13}	1.63×10^{-14}	2.02×10^{-9}	4.80×10^{-11}	9.60×10^{-14}

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Spill (Glovebox)	0.800	2.47×10^{-12}	2.80×10^{-13}	3.46×10^{-8}	8.24×10^{-10}	1.65×10^{-12}
Spill (Dock)	0.001	5.40×10^{-9}	5.40×10^{-10}	0.000063	1.50×10^{-6}	3.36×10^{-8}
Earthquake	0.000094	1.16×10^{-7}	1.16×10^{-8}	0.00135	0.0000322	7.21×10^{-7}
Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon						
Explosion (Hydrogen)	0.000015	5.10×10^{-12}	1.80×10^{-12}	2.70×10^{-7}	2.40×10^{-8}	1.20×10^{-11}
Explosion (Ion Exchange Column)	0.0001	1.87×10^{-10}	6.63×10^{-11}	9.64×10^{-6}	9.04×10^{-7}	4.48×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.0000155	1.60×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.07×10^{-9}	7.32×10^{-10}	0.00011	9.76×10^{-6}	4.88×10^{-9}
Spill	0.01	8.76×10^{-13}	3.09×10^{-13}	4.64×10^{-8}	4.12×10^{-9}	2.06×10^{-12}
Earthquake	0.000125	2.77×10^{-9}	5.11×10^{-10}	0.0000992	6.92×10^{-6}	5.29×10^{-7}
Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon						
Explosion (Hydrogen)	0.000015	4.80×10^{-12}	1.44×10^{-12}	2.40×10^{-7}	2.25×10^{-8}	1.20×10^{-11}
Explosion (Ion Exchange Column)	0.0001	2.10×10^{-10}	6.36×10^{-11}	0.0000103	1.02×10^{-6}	5.38×10^{-10}
Criticality (Liquid)	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.93×10^{-9}	8.78×10^{-10}	0.000146	0.0000137	7.32×10^{-9}
Spill	0.01	8.24×10^{-13}	2.47×10^{-13}	4.12×10^{-8}	3.86×10^{-9}	2.06×10^{-12}
Earthquake	0.000182	3.88×10^{-9}	7.88×10^{-10}	0.000174	0.0000113	1.98×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–220 Alternative 3 Accident Risks During the Mediated Electrochemical Oxidation Process at the Savannah River Site

Graphite Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Rocky Flats Packaging of Residues for Shipment to Savannah River Site						
All Residues	0.22	3.70×10^{-8}	3.70×10^{-9}	0.000431	0.0000103	2.30×10^{-7}
Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon						
All Residues	0.42	2.34×10^{-9}	6.43×10^{-10}	0.0000985	8.07×10^{-6}	2.25×10^{-7}
Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon						
All Residues	0.42	3.14×10^{-9}	7.90×10^{-10}	0.000142	0.0000115	8.36×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.8.4 Alternative 4 – Combination of Processing Technologies

The graphite residue processing technology considered for this alternative is repackaging. All graphite residue can be processed using this technology. The repackaging process technology accident descriptions,

consequences and risks are identical to those presented in Section D.3.4.8.1, Alternative 1 - No Action. Refer to Section D.3.4.8.1 for details.

D.3.4.9 Inorganic Residues

D.3.4.9.1 Alternative 1 – No Action

The inorganic residues processing technology considered for this alternative is repackaging. Preparation of repackaging of residues will be conducted at Rocky Flats within glovebox lines in Modules D, E, and F in Building 707.

Table D–221 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of repackaging of inorganic residues at Rocky Flats. **Table D–222** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the repackaging of inorganic residues at Rocky Flats. The risks associated with this processing technology are summarized in **Table D–223** and **Table D–224**.

Table D–221 Inorganic Residue Accident Scenario Parameters for Repackaging at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Inorganic Residues*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [b]	2	8,016 g
b. Loading Dock	2.0×10^{-6}	4 drums [c]	0	6,000 g
Spill:				
a. Room [d]	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	83.5 g
c. Loading Dock	0.001	1 drum [e]	0	3,000 g
Earthquake	0.0026	5-day supply [b]	0	8,016 g
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	1.0	0.001	0.10	1.0	Ground
Nuclear Criticality [f]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [g]	1.0 [g]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [g]	1.0 [g]	0.10	Ground
Earthquake	1.0	0.001 [h]	0.10 [h]	0.10	Ground
Aircraft Crash [j]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content

[b] 3-day supply of feed and 2-day supply of product.

[c] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[d] Materials are opened in a glovebox. No room spill is considered.

[e] 1 drum at the maximum plutonium content level.

[f] The wet nuclear criticality is not a viable accident scenario for the repackaging process in Building 707.

[g] The product of ARF×RF = 1.0×10^{-6}.
[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).
[j] Consequences enveloped by the earthquake.

Table D–222 Summary of the Inorganic Residue Accident Analysis Doses for Repackaging at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0481	Metal	0.115	0.0125	2,020	48.1	1.35
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.34×10^{-11}	2.00×10^{-11}	2.51×10^{-6}	1.29×10^{-7}	3.17×10^{-11}
Spill (Dock)	0.000075	Metal	0.00018	0.0000195	3.15	0.075	0.0021
Earthquake	0.234	Metal	0.562	0.0609	9,830	234	6.55

MEI = maximally exposed individual Met = meteorological data

Table D–223 Summary of the Inorganic Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for Repackaging at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	2.89×10^{-8}	3.13×10^{-9}	0.000505	0.000012	2.69×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	2.14×10^{-14}	8.02×10^{-15}	1.00×10^{-9}	5.14×10^{-11}	1.02×10^{-14}
Spill (Dock)	0.001	9.00×10^{-11}	9.75×10^{-12}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.0026	7.30×10^{-7}	7.91×10^{-8}	0.0128	0.000304	6.82×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–224 Alternative 1 Accident Risks During Inorganic Residue Processing

Inorganic Residue	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
All Residues	0.043	3.37×10^{-8}	3.65×10^{-9}	0.000589	0.000014	3.14×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.9.2 Alternative 2 – Processing without Plutonium Separation

The inorganic residues processing technologies considered for this alternative are calcination/vitrification and blend down. The calcination/vitrification process will be performed at Rocky Flats in Building 707, Modules D, E, and F. The blend down process will be performed at Rocky Flats in Building 707, Module E. Building 371

is under consideration as an alternate location for the blend down process. The accident analysis evaluates both the primary and alternate locations for the blend down process.

Similar accidents are applicable to the calcination/vitrification and blend down technologies. **Table D–225** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of inorganic residues processing at Rocky Flats. **Table D–226** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of inorganic residues. The risks associated with these processing technologies are summarized in **Table D–227** and **Table D–228**.

Table D–225 Inorganic Residue Accident Scenario Parameters for the Calcination/Vitrification Process and Blend Down Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Inorganic Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Calcination/ Vitrification Process [a]	*Blend Down Process* [b]
Explosion	0.00005	2 drums [c]	0/2 [d]	4,000 g	4,000 g
Nuclear criticality [e]	–	–	–	–	–
Fire:					
a. Room	0.0005	5-day supply [f]	2	4,810 g feed + 3,206 g product [g]	8,016 g
b. Loading Dock	2.0×10^{-6}	4 drums [h]	0	6,000 g	6,000 g
Spill:					
a. Room [j]	–	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	83.5 g	83.5 g
c. Loading Dock	0.001	1 drum [k]	0	3,000 g	3,000 g
Earthquake:					
a. Building 707	0.0026	5-day supply [f]	0	4,810 g feed + 3,206 g product [g]	8,016 g
b. Building 371	0.000094	5-day supply [f]	0	N/A	8,016 g
Aircraft Crash:					
a. Building 707	0.00003	Consequences enveloped by the earthquake.	–	–	–
b. Building 371	0.00004	The aircraft will not penetrate the building walls.	–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:					
a. Building 707	1.0	0.001	0.10	1.0	Ground
b. Building 371	1.0	0.001	0.10	2.0×10^{-6}	Elevated
Nuclear criticality [e]	–	–	–	–	–
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [l]	1.0 [l]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [l]	1.0 [l]	0.10	Ground
Earthquake	1.0	0.001 [m]	0.10 [m]	0.10	Ground
Aircraft Crash:					
a. Building 707 [n]	–	–	–	–	–
b. Building 371 [p]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] Building 707, Modules D, E, and F.
[b] Building 707, Module E.
[c] 1 drum at the maximum plutonium content level (3,000 grams) and 1 drum at the administrative control level (1,000 grams) for plutonium content.
[d] Building 371 2 HEPA Banks; Building 707, 0 HEPA Banks.
[e] The wet nuclear criticality is not a viable accident scenario for the calcination/vitrification and blend down technology assessments.
[f] 3-day supply of feed and 2-day supply of product.
[g] The product is glass. The effect of the vitrified product on the accident source term is negligible.
[h] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.
[j] Materials are opened in a glovebox. No room spill is considered.
[k] 1 drum at the maximum plutonium content level.
[l] The product of ARF×RF = 1.0×10^{-6}.
[m] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).
[n] Consequences enveloped by the earthquake.
[p] The aircraft will not penetrate the building walls.

Table D–226 Summary of the Inorganic Residue Accident Analysis Doses for the Calcination/Vitrification Process and Blend Down Process at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	***(grams)***	***Type***	***95% met***	***50% Met***	***95% Met***	***50% Met***	***50% Met***
Calcination/Vitrification Process							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0289	Metal	0.0693	0.0075	1,210	28.9	0.808
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.34×10^{-11}	2.00×10^{-11}	2.51×10^{-6}	1.29×10^{-7}	3.17×10^{-11}
Spill (Dock)	0.000075	Metal	0.00018	0.0000195	3.15	0.075	0.0021
Earthquake	0.140	Metal	0.337	0.0365	5,900	140	3.93
Blend Down Process—Building 707							
Explosion	0.400	Metal	0.960	0.104	16,800	400	11.2
Fire (Room)	0.0481	Metal	0.115	0.0125	2,020	48.1	1.35
Fire (Dock)	0.0018	Metal	0.00432	0.000468	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.34×10^{-11}	2.00×10^{-11}	2.51×10^{-6}	1.29×10^{-7}	3.17×10^{-11}
Spill (Dock)	0.000075	Metal	0.00018	0.0000195	3.15	0.075	0.0021
Earthquake	0.234	Metal	0.562	0.0609	9,830	234	6.55
Blend Down Process—Building 371							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.000800	2.00×10^{-6}
Fire (Room)	0.0481	Metal	0.173	0.0173	2,020	48.1	1.35
Fire (Dock)	0.00180	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	1.67×10^{-10}	Metal	5.01×10^{-10}	5.68×10^{-11}	7.01×10^{-6}	1.67×10^{-7}	4.18×10^{-10}
Spill (Dock)	0.0000750	Metal	0.000270	0.0000270	3.15	0.0750	0.00210
Earthquake	0.234	Metal	0.843	0.0843	9,830	234	6.55

MEI = maximally exposed individual Met = meteorological data

Table D–227 Summary of the Inorganic Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Calcination/Vitrification Process and Blend Down Process at Rocky Flats

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Calcination/Vitrification Process						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	1.73×10^{-8}	1.88×10^{-9}	0.000303	7.22×10^{-6}	1.62×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	2.14×10^{-14}	8.02×10^{-15}	1.00×10^{-9}	5.14×10^{-11}	1.02×10^{-14}
Spill (Dock)	0.001	9.00×10^{-11}	9.75×10^{-12}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.0026	4.38×10^{-7}	4.75×10^{-8}	0.00767	0.000183	4.09×10^{-6}
Blend Down Process—Building 707						
Explosion	0.00005	2.40×10^{-8}	2.60×10^{-9}	0.00042	0.00001	2.24×10^{-7}
Fire (Room)	0.0005	2.89×10^{-8}	3.13×10^{-9}	0.000505	0.000012	2.69×10^{-7}
Fire (Dock)	2.0×10^{-6}	4.32×10^{-12}	4.68×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	2.14×10^{-14}	8.02×10^{-15}	1.00×10^{-9}	5.14×10^{-11}	1.02×10^{-14}
Spill (Dock)	0.001	9.00×10^{-11}	9.75×10^{-12}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.0026	7.30×10^{-7}	7.91×10^{-8}	0.0128	0.000304	6.82×10^{-6}
Blend Down Process—Building 371						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	4.33×10^{-8}	4.33×10^{-9}	0.000505	0.0000120	2.69×10^{-7}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	2.00×10^{-13}	2.27×10^{-14}	2.81×10^{-9}	6.68×10^{-11}	1.34×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	3.96×10^{-8}	3.96×10^{-9}	0.000462	0.0000110	2.46×10^{-7}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–228 Alternative 2 Accident Risks During Inorganic Residue Processing

Inorganic Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Calcination/Vitrification Process						
All Residues	0.043	2.06×10^{-8}	2.23×10^{-9}	0.000361	8.59×10^{-6}	1.92×10^{-7}
Blend Down Process – Building 707						
All Residues	0.043	3.37×10^{-8}	3.65×10^{-9}	0.000589	0.000014	3.14×10^{-7}
Blend Down Process – Building 371						
All Residues	0.043	3.57×10^{-9}	3.57×10^{-10}	0.0000417	9.92×10^{-7}	2.22×10^{-8}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

[a] Sum of postulated accident scenario risks

D.3.4.9.3 Alternative 3 – Processing with Plutonium Separation

The inorganic residues processing technology considered for this alternative is mediated electrochemical oxidation. Processing of inorganic residues with the mediated electrochemical oxidation process may be performed at either Rocky Flats or the Savannah River Site. At Rocky Flats, most of the mediated electrochemical oxidation process will be performed in Building 371, Room 3701; the final calcination in the process will be performed in Building 707A, Module J. The packaging of the residues at Rocky Flats for processing at the Savannah River Site will be performed in Building 371, Room 371. The mediated electrochemical oxidation process will be performed in the canyon facilities at the Savannah River Site.

At each site similar accidents are applicable for the selected processes. **Table D–229** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of processing inorganic residues using mediated electrochemical oxidation technology at Rocky Flats. **Table D–230** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of inorganic residues at Rocky Flats. The risks associated with this processing technology at Rocky Flats are summarized in **Table D–231** and **Table D–232**.

Table D–229 Inorganic Residue Accident Scenario Parameters for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Inorganic Residues*	*HEPA Banks*	*Material at Risk (grams)*	
				Mediated Electrochemical Oxidation Process	
				Building 371	*Building 707A* [a]
Explosion (Acetylene)	0.00005	2 drums	2/0 [b]	4,000 g [c]	1,966 g
Explosion (Ion Exchange Column)	0.0001	Solution	2	0.245 mg [d]	N/A
Nuclear Criticality	0.0001	Solution	2	1.0×10^{19} fissions	N/A [e]
Fire:					
a. Room	0.0005	5-day supply [f]	2	5,376 g	5,898 g
b. Loading Dock	2.0×10^{-6}	4 drums	0	6,000 g [g]	3,932 g
Spill:					
a. Room [h]	–	–	–	–	–
b. Glovebox	0.80	1 feed prep container	2	194 g	983 g
c. Loading Dock	0.001	1 drum	0	3,000 g [j]	983 g
Earthquake:					
a. Building 371	0.000094	5-day supply [f]	0	5,376 g	N/A
b. Building 707A	0.0026	5-day supply [f]	0	N/A	5,898 g
Aircraft Crash:					
a. Building 371	0.00004	The aircraft will not penetrate the building wall.	–	–	N/A
b. Building 707A	0.00001	Consequences enveloped by the earthquake.	–	N/A	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion (Acetylene):					
a. Building 707A	1.0	0.001	0.010	1.0	Ground
b. Building 371	1.0	0.001	1.0	2.0×10^{-6}	Elevated
Explosion (Ion Exchange Column) [k]	1.0	1.0	1.0	1.0	Elevated
Nuclear Criticality [e, l]	–	–	–	–	Elevated

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Fire:					
a. Room	1.0	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Glovebox	1.0	1.0×10^{-6} [m]	1.0 [m]	2.0×10^{-6}	Elevated
b. Loading Dock	0.25	1.0×10^{-6} [m]	1.0 [m]	0.10	Ground
Earthquake:					
Buildings 371 and 707A	1.0	0.001 [d]	0.10 [d]	0.10	Ground
Aircraft Crash:					
a. Building 707A [n]	–	–	–	–	–
b. Building 371 [p]	–	–	–	–	–

N/A = not applicable DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 983-g product drums are transported from Building 371 to Building 707A for processing.

[b] Building 707A, 0 HEPA Banks; Building 371, 2 HEPA Banks.

[c] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[d] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).

[e] The wet nuclear criticality is not a viable accident scenario for the mediated electrochemical oxidation process in Building 707A.

[f] 3-day supply of feed and 2-day supply of product.

[g] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[h] Materials are opened in a glovebox. No room spill is considered.

[j] 1 drum at the maximum plutonium content level.

[k] Respirable source term value in milligrams of plutonium released up the stack.

[l] Refer to Table D–28 for Building 371 mediated electrochemical oxidation criticality accident source term.

[m] The product of ARF×RF = 1.0×10^{-6}.

[n] Consequences enveloped by the earthquake.

[p] The aircraft will not penetrate the building walls.

Table D–230 Summary of the Inorganic Residue Accident Analysis Doses for the Mediated Electrochemical Oxidation Process at Rocky Flats

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371							
Explosion (Acetylene)	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Explosion (Ion Exchange Column)	0.000245	Metal	0.000735	0.0000833	10.3	0.245	0.000613
Criticality (Liquid)	[a]	–	0.790	0.110	6,980	252	0.321
Fire (Room)	0.0323	Metal	0.116	0.0116	1,350	32.3	0.903
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	3.88×10^{-10}	Metal	1.16×10^{-9}	1.32×10^{-10}	0.0000163	3.88×10^{-7}	9.70×10^{-10}
Spill (Dock)	0.0000750	Metal	0.00027	0.000027	3.15	0.075	0.0021
Earthquake	0.157	Metal	0.565	0.0565	6,590	157	4.40
Building 707A							
Explosion (Acetylene)	0.197	Oxide	0.236	0.0256	4,920	118	4.13
Fire (Room)	0.0354	Oxide	0.0425	0.0046	895	21.2	0.743
Fire (Dock)	0.00118	Oxide	0.00142	0.000153	29.5	0.708	0.0248

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Spill (Glovebox)	1.97×10^{-9}	Oxide	3.15×10^{-10}	1.18×10^{-10}	0.0000171	8.85×10^{-7}	2.75×10^{-10}
Spill (Dock)	0.0000246	Oxide	0.0000295	3.19×10^{-6}	0.614	0.0147	0.000516
Earthquake	0.172	Oxide	0.207	0.0224	4,310	103	3.62

MEI = maximally exposed individual Met = meteorological data
[a] 1.0×10^{19} fissions.

Table D–231 Summary of the Inorganic Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Mediated Electrochemical Oxidation Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371						
Explosion (Acetylene)	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Explosion (Ion Exchange Column)	0.0001	3.68×10^{-11}	4.17×10^{-12}	5.15×10^{-7}	1.23×10^{-8}	2.45×10^{-11}
Criticality (Liquid)	0.0001	3.95×10^{-8}	5.50×10^{-9}	0.000349	0.0000126	1.28×10^{-8}
Fire (Room)	0.0005	2.90×10^{-8}	2.90×10^{-9}	0.000339	8.06×10^{-6}	1.81×10^{-7}
Fire (Dock)	2.0×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.80	4.66×10^{-13}	5.28×10^{-14}	6.52×10^{-9}	1.55×10^{-10}	3.10×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	2.66×10^{-8}	2.66×10^{-9}	0.00031	7.38×10^{-6}	1.65×10^{-7}
Building 707A						
Explosion (Acetylene)	0.00005	5.90×10^{-9}	6.39×10^{-10}	0.000123	2.95×10^{-6}	8.26×10^{-8}
Fire (Room)	0.0005	1.06×10^{-8}	1.15×10^{-9}	0.000221	5.31×10^{-6}	1.49×10^{-7}
Fire (Dock)	2.0×10^{-6}	1.42×10^{-12}	1.53×10^{-13}	2.95×10^{-8}	7.08×10^{-10}	1.98×10^{-11}
Spill (Glovebox)	0.80	1.26×10^{-13}	4.72×10^{-14}	6.84×10^{-9}	3.54×10^{-10}	8.81×10^{-14}
Spill (Dock)	0.001	1.47×10^{-11}	1.60×10^{-12}	3.07×10^{-7}	7.37×10^{-9}	2.06×10^{-10}
Earthquake	0.0026	2.69×10^{-7}	2.91×10^{-8}	0.00560	0.000134	3.76×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–232 Alternative 3 Accident Risks During Mediated Electrochemical Oxidation Processing at Rocky Flats

Inorganic Residue	*Process Duration (yr)*	*Risks [a]*				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Building 371						
All Residues	0.063	6.00×10^{-9}	6.98×10^{-10}	0.000063	1.77×10^{-6}	2.27×10^{-8}
Building 707A						
All Residues	0.058	1.65×10^{-8}	1.79×10^{-9}	0.000345	8.27×10^{-6}	2.32×10^{-7}

Inorganic Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Buildings 371 and 707A						
All Residues	–	2.25×10^{-8}	2.49×10^{-9}	0.000408	0.00001	2.54×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

Table D–233 provides the applicable accident scenarios, assumptions, and parameters used in determining the impacts of packaging the inorganic residues at Rocky Flats and of processing the residues using the mediated electrochemical oxidation technology at the Savannah River Site. **Table D–234** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from accidental releases associated with packaging the inorganic residues at Rocky Flats and processing the inorganic residues at the Savannah River Site. The risks associated with the packaging at Rocky Flats and the mediated electrochemical oxidation processing technology at the Savannah River Site are summarized in **Table D–235** and **Table D–236**. The processes at the Savannah River Site could be performed in either the F-Canyon and FB-Line or the H-Canyon and HB-Line. Data are presented in Table D–228, Table D–229, Table D–230, and Table D–231 for both options.

Table D–233 Inorganic Residue Accident Scenario Parameters for the Mediated Electrochemical Oxidation Process at the Savannah River Site

Accident Scenario	Frequency (per year)	Inorganic Residues	HEPA Banks	Material at Risk (grams)
Rocky Flats Packaging of Residue for Shipment to the Savannah River Site				
Explosion	0.00005	2 drums [a]	2	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire: a. Room b. Loading Dock	 0.0005 2.0×10^{-6}	 5-day supply [c] 4 drums [d]	 2 0	 6,636 g 6,000 g
Spill: a. Room [e] b. Glovebox c. Loading Dock	 – 0.80 0.001	 – 1 feed prep container 1 drum [f]	 – 2 0	 – 79 g 3,000 g
Earthquake	0.000094	5-day supply [c]	0	6,636 g
Aircraft Crash	0.000040	The aircraft will not penetrate the building wall.	–	–

Rocky Flats Packaging of Residue for Shipment to the Savannah River Site					
Accident Scenario	DR	ARF	RF	LPF	Release Point
Explosion	1.0	0.001	0.10	2.0×10^{-6}	Elevated
Nuclear Criticality [b]	–	–	–	–	–
Fire: a. Room b. Loading Dock	 1.0 0.01	 0.006 0.006	 0.01 0.01	 0.10 0.50	 Ground Ground
Spill: a. Glovebox b. Loading Dock	 1.0 0.25	 1.0×10^{-6} [g] 1.0×10^{-6} [g]	 1.0 [g] 1.0 [g]	 2.0×10^{-6} 0.10	 Elevated Ground
Earthquake	1.0	0.001 [h]	0.10 [h]	0.10	Ground

Rocky Flats Packaging of Residue for Shipment to the Savannah River Site					
Accident Scenario	***DR***	***ARF***	***RF***	***LPF***	***Release Point***
Aircraft Crash [j]	–	–	–	–	–
Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon					
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***			
Explosion: a. Hydrogen b. Ion Exchange Column	 0.000015 0.0001	 4,000 g 120.5 mg [k]			
Nuclear Criticality [l]	0.0001	1.0×10^{19} fissions			
Fire	0.00061	4,000 g			
Spill	0.01	79 g			
Earthquake: a. F-Canyon Liquid b. FB-Line Powder Molten Metal Liquid	0.000125	 12,000 g 1,000 g 1,000 g 1,000 g			
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***	
Explosion: a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.0010 1.0	 0.0050 1.0	 Elevated Elevated	
Nuclear Criticality [l]	–	–	–	–	
Fire	1.0	0.01	0.005	Elevated	
Spill	1.0	0.00001	0.005	Elevated	
Earthquake: a. F-Canyon Liquid b. FB-Line Powder Molten Metal Liquid	 1.0 1.0 1.0 1.0	 0.000047 0.002 0.0022 0.000047	 0.10 0.10 0.10 0.10	 Ground Ground Ground Ground	
Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon					
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***			
Explosion: a. Hydrogen b. Ion Exchange Column	 0.0000150 0.0001	 4,000 g 241 mg [k, m]			
Nuclear Criticality [l]	0.0001	1.0×10^{19} fissions			
Fire	0.00061	6,000 g			
Spill	0.01	79 g			
Earthquake: a. H-Canyon Liquid b. HB-Line Powder Liquid	0.000182	 27,000 g 4,000 g [m] 4,000 g [m]			
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***	
Explosion: a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.001 1.0	 0.005 1.0	 Elevated Elevated	

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Nuclear Criticality [l]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill	1.0	0.00001	0.005	Elevated
Earthquake:				
a. H-Canyon				
Liquid	1.0	0.000047	0.10	Ground
b. HB-Line				
Powder	1.0	0.002	0.10	Ground
Liquid	1.0	0.000047	0.10	Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the residue packaging process in Building 371.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] Materials are opened in a glovebox. No room spill is considered.

[f] 1 drum at the maximum plutonium content level.

[g] The product of ARF×RF = 1.0×10^{-6}.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).

[j] The aircraft will not penetrate the building walls.

[k] Respirable source term value in milligrams of plutonium released up the stack.

[l] Refer to Table D–28 for criticality accident source term.

[m] Duty cycle = 60%.

Table D–234 Summary of the Inorganic Residue Accident Analysis Doses for the Mediated Electrochemical Oxidation Process at the Savannah River Site

Accident Scenario	Building Source Term (grams)	Building Source Term Type	MEI (rem) 95% Met	MEI (rem) 50% Met	Population (person-rem) 95% Met	Population (person-rem) 50% Met	Worker (rem) 50% Met
Rocky Flats Packaging of Residues for Shipment to the Savannah River Site							
Explosion	8.00×10^{-7}	Metal	2.40×10^{-6}	2.72×10^{-7}	0.0336	0.0008	2.00×10^{-6}
Fire (Room)	0.0398	Metal	0.143	0.0143	1,670	39.8	1.11
Fire (Dock)	0.0018	Metal	0.00648	0.000648	75.6	1.80	0.0504
Spill (Glovebox)	1.58×10^{-10}	Metal	4.74×10^{-10}	5.37×10^{-11}	6.64×10^{-6}	1.58×10^{-7}	3.95×10^{-10}
Spill (Dock)	0.000075	Metal	0.00027	0.000027	3.15	0.075	0.0021
Earthquake	0.194	Metal	0.698	0.0698	8,140	194	5.43
Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon							
Explosion (Hydrogen)	0.02	Metal	0.00068	0.00024	36.0	3.20	0.002
Explosion (Ion Exchange Column)	0.121	Metal-FB	0.00374	0.00133	193	18.1	0.0112
Criticality (Liquid)	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.200	Metal	0.0068	0.0024	360	32.0	0.02
Spill	3.95×10^{-6}	Metal	1.34×10^{-7}	4.74×10^{-8}	0.00711	0.000632	3.95×10^{-7}
Earthquake	0.481	Metal	0.0443	0.00818	1,590	111	10.6
Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon							
Explosion (Hydrogen)	0.02	Metal	0.00064	0.000192	32.0	3.00	0.002
Explosion (Ion Exchange Column)	0.241	Metal-HB	0.00699	0.00212	342	34.0	0.0224
Criticality (Liquid)	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.300	Metal	0.0096	0.00288	480	45.0	0.03
Spill	3.95×10^{-6}	Metal	1.26×10^{-7}	3.79×10^{-8}	0.00632	0.000593	3.95×10^{-7}
Earthquake	0.946	Metal	0.0653	0.0132	2,930	189	20.8

MEI = maximally exposed individual Met = meteorological data
[a] 1.0×10^{19} fissions.

Table D–235 Summary of the Inorganic Residue Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Mediated Electrochemical Oxidation Process at the Savannah River Site

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr) 95% Met	MEI (LCF/yr) 50% Met	Population (LCF/yr) 95% Met	Population (LCF/yr) 50% Met	Worker (LCF/yr) 50% Met
Rocky Flats Packaging of Residues for Shipment to the Savannah River Site						
Explosion	0.00005	6.00×10^{-14}	6.80×10^{-15}	8.40×10^{-10}	2.00×10^{-11}	4.00×10^{-14}
Fire (Room)	0.0005	3.58×10^{-8}	3.58×10^{-9}	0.000418	9.95×10^{-6}	2.23×10^{-7}
Fire (Dock)	2.00×10^{-6}	6.48×10^{-12}	6.48×10^{-13}	7.56×10^{-8}	1.80×10^{-9}	4.03×10^{-11}
Spill (Glovebox)	0.800	1.90×10^{-13}	2.15×10^{-14}	2.65×10^{-9}	6.32×10^{-11}	1.26×10^{-13}
Spill (Dock)	0.001	1.35×10^{-10}	1.35×10^{-11}	1.58×10^{-6}	3.75×10^{-8}	8.40×10^{-10}
Earthquake	0.000094	3.28×10^{-8}	3.28×10^{-9}	0.000383	9.11×10^{-6}	2.04×10^{-7}

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon						
Explosion (Hydrogen)	0.000015	5.10×10^{-12}	1.80×10^{-12}	2.70×10^{-7}	2.40×10^{-8}	1.20×10^{-11}
Explosion (Ion Exchange Column)	0.0001	1.87×10^{-10}	6.63×10^{-11}	9.64×10^{-6}	9.04×10^{-7}	4.48×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.000155	1.60×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.07×10^{-9}	7.32×10^{-10}	0.00011	9.76×10^{-6}	4.88×10^{-9}
Spill	0.01	6.72×10^{-13}	2.37×10^{-13}	3.56×10^{-8}	3.16×10^{-9}	1.58×10^{-12}
Earthquake	0.000125	2.77×10^{-9}	5.11×10^{-10}	0.0000992	6.92×10^{-6}	5.29×10^{-7}
Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon						
Explosion (Hydrogen)	0.000015	4.80×10^{-12}	1.44×10^{-12}	2.40×10^{-7}	2.25×10^{-8}	1.20×10^{-11}
Explosion (Ion Exchange Column)	0.0001	2.10×10^{-10}	6.36×10^{-11}	0.0000103	1.02×10^{-6}	5.38×10^{-10}
Criticality (Liquid)	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.93×10^{-9}	8.78×10^{-10}	0.000146	0.0000137	7.32×10^{-9}
Spill	0.01	6.32×10^{-13}	1.90×10^{-13}	3.16×10^{-8}	2.96×10^{-9}	1.58×10^{-12}
Earthquake	0.000182	3.88×10^{-9}	7.88×10^{-10}	0.000174	0.0000113	1.980×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–236 Alternative 3 Accident Risks During the Mediated Electrochemical Oxidation Process at the Savannah River Site

Inorganic Residue	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Rocky Flats Packaging of Residues for Shipment to Savannah River Site						
All Residues	0.051	3.51×10^{-9}	3.51×10^{-10}	0.0000409	9.74×10^{-7}	2.18×10^{-8}
Mediated Electrochemical Oxidation Process at the Savannah River Site F-Canyon						
All Residues	0.42	2.34×10^{-9}	6.43×10^{-10}	0.0000985	8.07×10^{-6}	2.25×10^{-7}
Mediated Electrochemical Oxidation Process at the Savannah River Site H-Canyon						
All Residues	0.42	3.14×10^{-9}	7.90×10^{-10}	0.000145	0.0000115	8.36×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.9.4 Alternative 4 – Combination of Processing Technologies

The inorganic residue processing technology considered for this alternative is repackaging. All inorganic residue can be processed using this technology. The repackaging process technology accident descriptions, consequences and risks are identical to those presented in Section D.3.4.9.1, Alternative 1 - No Action. Refer to Section D.3.4.9.1 for details.

D.3.4.10 Scrub Alloy

D.3.4.10.1 Alternative 1 – No Action

The scrub alloy processing technology considered for this alternative is repackaging. Repackaging of residues will be conducted within glovebox lines in Modules D, E, and F in Building 707 at Rocky Flats.

Table D–237 provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of repackaging of scrub alloy at Rocky Flats. **Table D–238** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with repackaging scrub alloy at Rocky Flats. The risks associated with this processing technology are summarized in **Table D–239** and **Table D–240**.

Table D–237 Scrub Alloy Accident Scenario Parameters the Repackaging at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Scrub Alloy*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear Criticality	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [b]	2	34,800 g
b. Loading Dock	2.0×10^{-6}	4 drums [c]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the maximum limit [d]	2	3,000 g
b. Glovebox	0.80	1 feed prep container	2	725 g
c. Loading Dock	0.001	1 drum [e]	0	3,000 g
Earthquake	0.0026	5-day supply [b]	0	34,800 g
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion:	0.01	0.00001	1.0	1.0	Ground
Nuclear Criticality [f]	–	–	–	–	–
Fire:					
a. Room	0.01	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Room	0.01	1.0×10^{-6} [g]	1.0 [g]	2.0×10^{-6}	Elevated
b. Glovebox	0.01	1.0×10^{-6} [g]	1.0 [g]	2.0×10^{-6}	Elevated
c. Loading Dock	0.01	1.0×10^{-6} [g]	1.0 [g]	0.10	Ground
Earthquake	0.01	0.001 [h]	0.10 [h]	0.10	Ground
Aircraft Crash [j]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] 3-day supply of feed and 2-day supply of product.

[c] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[d] 1 container per drum of feed.

[e] 1 drum at the maximum plutonium content level.

[f] The wet nuclear criticality is not a viable accident scenario for the direct repackaging process in Building 707.

[g] The product of ARF×RF + 1.0×10^{-6}.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).

[j] Consequences enveloped by the earthquake.

Table D–238 Summary of the Scrub Alloy Accident Analysis Doses for Repackaging at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.0004	Salt-O	0.0056	0.0006	104	2.48	0.068
Fire (Room)	0.00209	Salt-O	0.0292	0.00313	543	12.9	0.355
Fire (Dock)	0.0018	Salt-O	0.0252	0.0027	468	11.2	0.306
Spill (Room)	6.00×10^{-11}	Salt-O	1.14×10^{-10}	4.32×10^{-11}	5.40×10^{-6}	2.76×10^{-7}	7.20×10^{-11}
Spill (Glovebox)	1.45×10^{-11}	Salt-O	2.76×10^{-11}	1.04×10^{-11}	1.31×10^{-6}	6.67×10^{-8}	1.74×10^{-11}
Spill (Dock)	3.00×10^{-6}	Salt-O	0.0000420	4.50×10^{-6}	0.780	0.0186	0.00051
Earthquake	0.0102	Salt-O	0.142	0.0152	2,640	63.0	1.73

MEI = maximally exposed individual Met = meteorological data Salt-O = oxide salt

Table D–239 Summary of the Scrub Alloy Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for Repackaging at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.00005	1.40×10^{-10}	1.50×10^{-11}	2.60×10^{-6}	6.20×10^{-8}	1.36×10^{-9}
Fire (Room)	0.0005	7.31×10^{-9}	7.83×10^{-10}	0.000136	3.24×10^{-6}	7.10×10^{-8}
Fire (Dock)	2.0×10^{-6}	2.52×10^{-11}	2.70×10^{-12}	4.68×10^{-7}	1.12×10^{-8}	2.45×10^{-10}
Spill (Room)	0.008	4.56×10^{-16}	1.73×10^{-16}	2.16×10^{-11}	1.10×10^{-12}	2.30×10^{-16}
Spill (Glovebox)	0.80	1.10×10^{-14}	4.18×10^{-15}	5.22×10^{-10}	2.67×10^{-11}	5.57×10^{-15}
Spill (Dock)	0.001	2.10×10^{-11}	2.25×10^{-12}	3.90×10^{-7}	9.30×10^{-9}	2.04×10^{-10}
Earthquake	0.0026	1.85×10^{-7}	1.98×10^{-8}	0.00343	0.0000819	1.80×10^{-6}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–240 Alternative 1 Accident Risks During Scrub Alloy Processing

Scrub Alloy	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
All Scrub Alloy	0.11	2.12×10^{-8}	2.27×1^{-9}	0.000393	9.37×10^{-6}	2.06×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

[a] Sum of postulated accident scenario risks

D.3.4.10.2 Alternative 2 – Processing without Plutonium Separation

The scrub alloy processing technology considered for this alternative is calcination/vitrification. The calcination/vitrification process will be performed at Rocky Flats in Building 707, Modules D, E, and F. **Table D–241** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of scrub alloy processing at Rocky Flats. **Table D–242** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of scrub alloy. The risks associated with this processing technology are summarized in **Table D–243** and **Table D–244**.

Table D–241 Scrub Alloy Accident Scenario Parameters for the Calcination/Vitrification Process at Rocky Flats

Accident Scenario	*Frequency (per year)*	*Scrub Alloy*	*HEPA Banks*	*Material at Risk (grams)*
Explosion	0.00005	2 drums [a]	0	4,000 g
Nuclear criticality [b]	–	–	–	–
Fire:				
a. Room	0.0005 2.0×10^{-6}	5-day supply [c]	2	1,043 g supply + 695 g product [d]
b. Loading Dock		4 drums [e]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the limit [f]	2	3,000 g
b. Glovebox	0.80	1 feed prep container [f]	2	725 g
c. Loading Dock	0.001	1 drum [g]	0	3,000 g
Earthquake	0.0026	5-day supply [c]	0	1,043 g supply + 695 g product [d]
Aircraft Crash	0.00003	Consequences enveloped by the earthquake.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	0.01	0.00001	1.0	1.0	Ground
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room	0.01	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Room	0.01	1.0×10^{-6} [h]	1.0 [h]	2.0×10^{-6}	Elevated
b. Glovebox	0.01	1.0×10^{-6} [h]	1.0 [h]	2.0×10^{-6}	Elevated
c. Loading Dock	0.01	1.0×10^{-6} [h]	1.0 [h]	0.10	Ground
Earthquake	0.01	0.001 [j]	0.10 [j]	0.10	Ground
Aircraft Crash [k]	–	–	–	–	–

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 grams) and 1 drum at the administrative control level (1,000 grams) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the calcination/vitrification technology assessment.

[c] 3-day supply of feed and 2-day supply of product.

[d] The product is glass. The effect of the vitrified product on the accident source term is negligible.

[e] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[f] 1 container per drum of feed.

[g] 1 drum at the maximum plutonium content level.

[h] The product of ARF×RF = 1.0×10^{-6}.

[j] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).

[k] Consequences enveloped by the earthquake.

Table D–242 Summary of the Scrub Alloy Accident Analysis Doses for the Calcination/Vitrification Process at Rocky Flats

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.0004	Salt-O	0.0056	0.0006	104	2.48	0.068
Fire (Room)	0.0000626	Salt-O	0.000876	0.0000939	16.3	0.388	0.0106
Fire (Dock)	0.0018	Salt-O	0.0252	0.0027	468	11.2	0.306
Spill (Room)	6.00×10^{-11}	Salt-O	1.14×10^{-10}	4.32×10^{-11}	5.40×10^{-6}	2.76×10^{-7}	7.20×10^{-11}
Spill (Glovebox)	1.45×10^{-11}	Salt-O	2.76×10^{-11}	1.04×10^{-11}	1.31×10^{-6}	6.67×10^{-8}	1.74×10^{-11}
Spill (Dock)	3.00×10^{-6}	Salt-O	0.000042	4.50×10^{-6}	0.780	0.0186	0.00051
Earthquake	0.000305	Salt-O	0.00426	0.000457	79.2	1.89	0.0518

MEI = maximally exposed individual Met = meteorological data Salt-O = oxide salt

Table D–243 Summary of the Scrub Alloy Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Calcination/Vitrification Process at Rocky Flats

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion	0.00005	1.40×10^{-10}	1.50×10^{-11}	2.60×10^{-6}	6.20×10^{-8}	1.36×10^{-9}
Fire (Room)	0.0005	2.19×10^{-10}	2.35×10^{-11}	4.07×10^{-6}	9.70×10^{-8}	2.13×10^{-9}
Fire (Dock)	2.0×10^{-6}	2.52×10^{-11}	2.70×10^{-12}	4.68×10^{-7}	1.12×10^{-8}	2.45×10^{-10}
Spill (Room)	0.008	4.56×10^{-16}	1.73×10^{-16}	2.16×10^{-11}	1.10×10^{-12}	2.30×10^{-16}
Spill (Glovebox)	0.80	1.10×10^{-14}	4.18×10^{-15}	5.22×10^{-10}	2.67×10^{-11}	5.57×10^{-15}
Spill (Dock)	0.001	2.10×10^{-11}	2.25×10^{-12}	3.90×10^{-7}	9.30×10^{-9}	2.04×10^{-10}
Earthquake	0.0026	5.54×10^{-9}	5.94×10^{-10}	0.000103	2.45×10^{-6}	5.38×10^{-8}

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–244 Alternative 2 Accident Risks During Scrub Alloy Processing

Scrub Alloy	*Process Duration (yr)*	*Risks* [a]				
		MEI (LCF)		*Population (LCF)*		*Worker (LCF)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
All Scrub Alloy	2.21	1.31×10^{-8}	1.41×10^{-9}	0.000244	5.82×10^{-6}	1.28×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality

[a] Sum of postulated accident scenario risks

D.3.4.10.3 Alternative 3 – Processing with Plutonium Separation

The scrub alloy processing technology considered for this alternative is the Purex/plutonium metal (or oxide) recovery process at the Savannah River Site. The scrub alloy will be packaged at Rocky Flats and shipped to the Savannah River Site for processing. The packaging of the residues at Rocky Flats will be performed in Building 371, Room 3701. The Purex process will be performed in the canyon facilities at the Savannah River Site.

Similar accidents are applicable to the facilities at both sites. **Table D–245** provides the applicable accident scenarios, assumptions, and parameters used in determining the impact of scrub alloy processing at the Savannah River Site. **Table D–246** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the processing of scrub alloy. The risks associated with this processing technology are summarized in **Table D–247** and **Table D–248**. The processes at the Savannah River Site could be performed either in the F-Canyon and FB-Line or in the H-Canyon and HB-Line. Data are presented in Table D–252, Table D–253, Table D–254, and Table D–255 for both options.

Table D–245 Scrub Alloy Accident Scenario Parameters for the Purex/Plutonium Metal or Oxide Recovery Process at the Savannah River Site

Accident Scenario	*Frequency (per year)*	*Scrub Alloy*	*HEPA Banks*	*Material at Risk (grams)*
Rocky Flats Packaging of Residues for Shipment to the Savannah River Site				
Explosion	0.00005	2 drums [a]	2	4,000 g
Nuclear Criticality [b]	–	–	–	–
Fire:				
a. Room	0.0005	5-day supply [c]	2	20,412 g
b. Loading Dock	2.0×10^{-6}	4 drums [d]	0	6,000 g
Spill:				
a. Room	0.008	1 container at the maximum limit [e]	2	3,000 g
b. Glovebox	0.80	1 feed prep container	2	725 g
c. Loading Dock	0.001	1 drum [f]	0	3,000 g
Earthquake	0.000094	5-day supply [c]	0	20,412 g
Aircraft Crash	0.00004	The aircraft will not penetrate the building wall.	–	–

Accident Scenario	*DR*	*ARF*	*RF*	*LPF*	*Release Point*
Explosion	0.01	0.00001	1.0	2.0×10^{-6}	Elevated
Nuclear Criticality [b]	–	–	–	–	–
Fire:					
a. Room	0.01	0.006	0.01	0.10	Ground
b. Loading Dock	0.01	0.006	0.01	0.50	Ground
Spill:					
a. Room	0.01	1.0×10^{-6} [g]	1.0 [g]	2.0×10^{-6}	Elevated
b. Glovebox	0.01	1.0×10^{-6} [g]	1.0 [g]	2.0×10^{-6}	Elevated
c. Loading Dock	0.01	1.0×10^{-6} [g]	1.0 [g]	0.10	Ground
Earthquake	0.01	0.001 [h]	0.10 [h]	0.10	Ground
Aircraft Crash [j]	–	–	–	–	–

Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon				
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***		
Explosion: a. Hydrogen b. Ion Exchange Column	 0.000015 0.0001	 8,000 g 241 mg [k]		
Nuclear Criticality [l]	0.0001	1.0×10^{19} fissions		
Fire	0.00061	8,000 g		
Spill [m]	–	–		
Earthquake: a. F-Canyon Liquid b. FB-Line: Powder Molten Metal Liquid	0.000125	 24,000 g 2,000 g 2,000 g 2,000 g		
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion: a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.001 1.0	 0.005 1.0	 Elevated Elevated
Nuclear Criticality [l]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill [m]	–	–	–	–
Earthquake: a. F-Canyon Liquid b. FB-Line Powder Molten Metal Liquid	 1.0 1.0 1.0 1.0	 0.000047 0.002 0.0022 0.000047	 0.10 0.10 0.10 0.10	 Ground Ground Ground Ground
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon				
Accident Scenario	***Frequency (per year)***	***Material at Risk (grams)***		
Explosion: a. Hydrogen b. Ion Exchange Column	 0.000015 0.0001	 6,000 g 241 mg [m]		
Nuclear Criticality [l]	0.0001	1.0×10^{19} fissions		
Fire	0.00061	6,000 g		
Spill [m]	–	–		
Earthquake: a. H-Canyon Liquid b. HB-Line Powder Liquid	0.000182	 18,000 g 4,000 g 4,000 g		
Accident Scenario	***DR***	***ARF×RF***	***LPF***	***Release Point***
Explosion: a. Hydrogen b. Ion Exchange Column	 1.0 1.0	 0.001 1.0	 0.005 1.0	 Elevated Elevated
Nuclear Criticality [l]	–	–	–	–
Fire	1.0	0.01	0.005	Elevated
Spill [m]	–	–	–	–

Accident Scenario	*DR*	*ARF×RF*	*LPF*	*Release Point*
Earthquake:				
a. H-Canyon				
Liquid	1.0	0.000047	0.10	Ground
b. HB-Line				
Powder	1.0	0.002	0.10	Ground
Liquid	1.0	0.000047	0.10	Ground

DR = damage ratio ARF = airborne release fraction RF = respirable fraction LPF = leak path factor

[a] 1 drum at the maximum plutonium content level (3,000 g) and 1 drum at the administrative control level (1,000 g) for plutonium content.

[b] The wet nuclear criticality is not a viable accident scenario for the residue packaging process in Building 371.

[c] 3-day supply of feed and 2-day supply of product.

[d] 1 drum at the maximum plutonium content level and 3 drums at the administrative control level for plutonium content.

[e] 1 container per drum of feed.

[f] 1 drum at the maximum plutonium content level.

[g] The product of ARF×RF = 1.0×10^{-6}.

[h] Add 0.000192 to all ARF×RF values for the resuspension of respirable particulates after the earthquake (e.g., ARF×RF + 0.000192 = 0.000292).

[j] The aircraft will not penetrate the building walls.

[k] Respirable source term value in milligrams of plutonium released up the stack.

[l] Refer to Table D–28 for criticality accident source term.

[m] Powder spill is not a viable accident scenario for processing scrub alloy at the Savannah River Site.

Table D–246 Summary of the Scrub Alloy Accident Analysis Doses for the Purex/Plutonium Metal or Oxide Recovery Process at the Savannah River Site

	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Accident Scenario	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Packaging of Residues for Shipment to the Savannah River Site							
Explosion	8.00×10^{-10}	Salt-O	1.44×10^{-8}	1.68×10^{-9}	0.000208	4.88×10^{-6}	1.28×10^{-8}
Fire (Room)	0.00122	Salt-O	0.0269	0.00269	318	7.59	0.208
Fire (Dock)	0.0018	Salt-O	0.0396	0.00396	468	11.2	0.306
Spill (Room)	6.00×10^{-11}	Salt-O	1.08×10^{-9}	1.26×10^{-10}	0.0000156	3.66×10^{-7}	9.60×10^{-10}
Spill (Glovebox)	1.45×10^{-11}	Salt-O	2.61×10^{-10}	3.05×10^{-11}	3.77×10^{-6}	8.85×10^{-8}	2.32×10^{-10}
Spill (Dock)	3.00×10^{-6}	Salt-O	0.000066	6.60×10^{-6}	0.780	0.0186	0.00051
Earthquake	0.00596	Salt-O	0.131	0.0131	1,550	37.0	1.01
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon							
Explosion (Hydrogen)	0.04	Salt-M	0.0088	0.00328	480	40.0	0.0264
Explosion (Ion Exchange Column)	0.241	Salt-FB	0.00747	0.00265	386	36.2	0.0224
Criticality (Liquid)	[a]	–	0.011	0.0044	310	32.0	0.038
Fire	0.400	Salt-M	0.088	0.0328	4,800	400	0.264
Earthquake	0.962	Salt-M	0.577	0.106	20,200	1,440	144
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon							

Accident Scenario	*Building Source Term*		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
	(grams)	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Explosion (Hydrogen)	0.03	Salt-M	0.0063	0.00189	330	28.8	0.0198
Explosion (Ion Exchange Column)	0.241	Salt-HB	0.00747	0.00205	354	34.7	0.0231
Criticality (Liquid)	[a]	–	0.009	0.003	290	29.0	0.038
Fire	0.300	Salt-M	0.063	0.0189	3,300	288	0.198
Earthquake	0.903	Salt-M	0.407	0.0813	18,100	1,170	136

MEI = maximally exposed individual Met = meteorological data Salt-M = metal salt Salt-O = oxide salt
Salt-FB = salt generated in FB area Salt HB = salt generated in HB area
[a] 1.0×10^{19} fissions.

Table D–247 Summary of the Scrub Alloy Accident Analysis Risks in Terms of Latent Cancer Fatalities per Year for the Purex/Plutonium Metal or Oxide Recovery Process at the Savannah River Site

Accident Scenario	*Accident Frequency (per year)*	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Rocky Flats Packaging of Residues for Shipment to the Savannah River Site						
Explosion	0.00005	3.60×10^{-16}	4.20×10^{-17}	5.20×10^{-12}	1.22×10^{-13}	2.56×10^{-16}
Fire (Room)	0.0005	6.74×10^{-9}	6.74×10^{-10}	0.0000796	1.90×10^{-6}	4.16×10^{-8}
Fire (Dock)	2.0×10^{-6}	3.96×10^{-11}	3.96×10^{-12}	4.68×10^{-7}	1.12×10^{-8}	2.45×10^{-10}
Spill (Room)	0.008	4.32×10^{-15}	5.04×10^{-16}	6.24×10^{-11}	1.46×10^{-12}	3.07×10^{-15}
Spill (Glovebox)	0.80	1.04×10^{-13}	1.22×10^{-14}	1.51×10^{-9}	3.54×10^{-11}	7.42×10^{-14}
Spill (Dock)	0.001	3.30×10^{-11}	3.30×10^{-12}	3.90×10^{-7}	9.30×10^{-9}	2.04×10^{-10}
Earthquake	0.000094	6.16×10^{-9}	6.16×10^{-10}	0.0000728	1.74×10^{-6}	3.81×10^{-8}
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon						
Explosion (Hydrogen)	0.000015	6.60×10^{-11}	2.46×10^{-11}	3.60×10^{-6}	3.00×10^{-7}	1.58×10^{-10}
Explosion (Ion Exchange Column)	0.0001	3.74×10^{-10}	1.33×10^{-10}	0.0000193	1.81×10^{-6}	8.97×10^{-10}
Criticality (Liquid)	0.0001	5.50×10^{-10}	2.20×10^{-10}	0.0000155	1.60×10^{-6}	1.52×10^{-9}
Fire	0.00061	2.68×10^{-8}	1.00×10^{-8}	0.00146	0.000122	6.44×10^{-8}
Earthquake	0.000125	3.61×10^{-8}	6.62×10^{-9}	0.00126	0.0000902	0.0000144

Accident Scenario	Accident Frequency (per year)	MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon						
Explosion (Hydrogen)	0.000015	4.73×10^{-11}	1.42×10^{-11}	2.48×10^{-6}	2.16×10^{-7}	1.19×10^{-10}
Explosion (Ion Exchange Column)	0.0001	3.74×10^{-10}	1.02×10^{-10}	0.0000177	1.74×10^{-6}	9.25×10^{-10}
Criticality (Liquid)	0.0001	4.50×10^{-10}	1.50×10^{-10}	0.0000145	1.45×10^{-6}	1.52×10^{-9}
Fire	0.00061	1.92×10^{-8}	5.76×10^{-9}	0.00101	0.0000878	4.83×10^{-8}
Earthquake	0.000182	3.70×10^{-8}	7.40×10^{-9}	0.00164	0.000107	0.0000197

MEI = maximally exposed individual LCF = latent cancer fatality Met = meteorological data

Table D–248 Alternative 3 Accident Risks During the Purex/Metal or Oxide Recovery Process at the Savannah River Site

Scrub Alloy	Process Duration (yr)	Risks [a]				
		MEI (LCF)		Population (LCF)		Worker (LCF)
		95% Met	50% Met	95% Met	50% Met	50% Met
Rocky Flats Packaging of Residues for Shipment to Savannah River Site						
All Scrub Alloy	0.12	1.56×10^{-9}	1.56×10^{-10}	0.0000184	4.39×10^{-7}	9.62×10^{-9}
Purex/Plutonium Metal Recovery Process at the Savannah River Site F-Canyon						
All Scrub Alloy	0.50	3.20×10^{-8}	8.50×10^{-9}	0.00138	0.000108	7.25×10^{-6}
Purex/Plutonium Oxide Recovery Process at the Savannah River Site H-Canyon						
All Scrub Alloy	0.50	2.85×10^{-8}	6.71×10^{-9}	0.00134	0.0000991	9.89×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality
[a] Sum of postulated accident scenario risks

D.3.4.10.4 Alternative 4 - Combination of Processing Technologies

Scrub alloy is not under consideration for Alternative 4.

D.3.4.11 Storage Following Processing and Packaging

D.3.4.11.1 Alternative 1 – No Action

Table D–249 presents a summary of the stored material vulnerability to the postulated set of accidents. **Table D–250** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the storage of residues and scrub alloy following processing and packaging using Alternative 1 processing technologies. The storage risks associated with Alternative 1 are presented in **Table D–251**.

Table D–249 Stored Material Location Vulnerability to Postulated Accidents

Accident	*Butler Building*	*Building 371 Vault*
High Wind	Yes	No
Small Aircraft Crash	Yes	No
Room/Vault Fire	Yes	Yes
Earthquake and Building Collapse	Yes	Yes

Table D–250 Alternative 1 Storage Accident Consequences

	Building Source Term		*Doses*				
			MEI (rem)		*Population (person-rem)*		*Worker (rem)*
Material	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
High Wind Accident – Butler Building							
Combustible Residue	2.32×10^{-6}	Metal	5.57×10^{-6}	6.03×10^{-7}	0.0974	0.00232	0.0000650
Fluoride Residue	0.00016	Metal-O	0.000192	0.0000208	4.00	0.0960	0.00336
Filter Media Residue	2.32×10^{-6}	Metal	5.57×10^{-6}	6.03×10^{-7}	0.0974	0.00232	0.0000650
Sludge Residue	0.0000928	Metal	0.000223	0.0000241	3.90	0.0928	0.00260
Small Aircraft Crash – Butler Building							
Combustible Residue	0.0695	Metal	0.167	0.0181	2,920	69.5	1.95
Fluoride Residue	0.000240	Metal-O	0.000288	0.0000312	6.00	0.144	0.00504
Filter Media Residue	0.00834	Metal	0.0200	0.00217	350	8.34	0.234
Sludge Residue	0.00834	Metal	0.0200	0.00217	350	8.34	0.234
Room Fire – Butler Building							
Combustible Residue	0.0116	Metal	0.0278	0.00302	487	11.6	0.325
Fluoride Residue	0.0000400	Metal-O	0.0000480	5.20×10^{-6}	1.00	0.0240	0.000840
Filter Media Residue	0.00696	Metal	0.0167	0.00181	292	6.96	0.195
Sludge Residue	0.00278	Metal	0.00668	0.000724	117	2.78	0.0780
Vault Fire – Building 371							
Scrub Alloy	0.0000435	Metal-O	0.0000783	7.83×10^{-6}	1.09	0.0261	0.000914
Earthquake and Building Collapse – Butler Building							
Combustible Residue	0.00411	Metal	0.00987	0.00107	173	4.11	0.115
Fluoride Residue	0.0000928	Metal-O	0.000111	0.0000121	2.32	0.0557	0.00195

Material	Building Source Term		Doses				
			MEI (rem)		Population (person-rem)		Worker (rem)
	(grams)	Type	95% Met	50% Met	95% Met	50% Met	50% Met
Filter Media Residue	0.0216	Metal	0.519	0.00562	908	21.6	0.605
Sludge Residue	0.00612	Metal	0.0147	0.00159	257	6.12	0.171
Earthquake and Building Collapse – Building 371 Vault							
Fluoride Residue Reside	0.112	Metal-O	0.201	0.0201	2,790	67.0	2.35
Scrub Alloy	0.0584	Metal-O	0.105	0.0105	1,460	35.0	1.23

MEI = maximally exposed individual Met = meteorological data Metal-O = metal oxide

Table D–251 Alternative 1 Storage Accident Risks in Terms of Latent Cancer Fatalities per Year

Material	Accident Frequency (per yr)	Risks				
		MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
High Wind Accident – Butler Building						
Combustible Residue	0.000814	2.27×10^{-12}	2.46×10^{-13}	3.97×10^{-8}	9.44×10^{-10}	2.12×10^{-11}
Fluoride Residue	8.89×10^{-6}	8.53×10^{-13}	9.25×10^{-14}	1.78×10^{-8}	4.27×10^{-10}	1.19×10^{-11}
Filter Media Residue	0.00429	1.19×10^{-11}	1.29×10^{-12}	2.09×10^{-7}	4.98×10^{-9}	1.11×10^{-10}
Sludge Residue	0.00101	1.12×10^{-10}	1.22×10^{-11}	1.97×10^{-6}	4.69×10^{-8}	1.05×10^{-9}
Small Aircraft Crash – Butler Building						
Combustible Residue	2.44×10^{-7}	2.03×10^{-11}	2.2×10^{-12}	3.56×10^{-7}	8.48×10^{-9}	1.90×10^{-10}
Fluoride Residue	2.67×10^{-7}	3.84×10^{-14}	4.17×10^{-15}	8.01×10^{-10}	1.92×10^{-11}	5.38×10^{-13}
Filter Media Residue	1.29×10^{-6}	1.29×10^{-11}	1.40×10^{-12}	2.26×10^{-7}	5.38×10^{-9}	1.20×10^{-10}
Sludge Residue	3.03×10^{-7}	3.03×10^{-12}	3.29×10^{-13}	5.31×10^{-8}	1.26×10^{-9}	2.83×10^{-11}
Room Fire – Butler Building						
Combustible Residue	0.00001	1.39×10^{-10}	1.51×10^{-11}	2.44×10^{-6}	5.80×10^{-8}	1.30×10^{-9}
Fluoride Residue	0.00001	2.40×10^{-13}	2.60×10^{-14}	5.00×10^{-9}	1.20×10^{-10}	3.36×10^{-12}
Filter Media Residue	0.00001	8.35×10^{-11}	9.05×10^{-12}	1.46×10^{-6}	3.48×10^{-8}	7.80×10^{-10}

Material	Accident Frequency (per yr)	Risks				
		MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
Sludge Residue	0.00001	3.34×10^{-10}	3.62×10^{-12}	5.85×10^{7}	1.39×10^{-8}	3.12×10^{-10}
Vault Fire – Building 371						
Scrub Alloy	1.0×10^{-6}	3.92×10^{-14}	3.92×10^{-15}	5.44×10^{-10}	1.31×10^{-11}	3.65×10^{-13}
Earthquake and Building Collapse – Butler Building						
Combustible Residue	0.002	9.87×10^{-9}	1.07×10^{-9}	0.000173	4.11×10^{-6}	9.21×10^{-8}
Fluoride Residue	0.002	1.11×10^{-10}	1.21×10^{-11}	2.32×10^{-6}	5.57×10^{-8}	1.56×10^{-9}
Filter Media Residue	0.002	5.19×10^{-8}	5.62×10^{-9}	0.000908	0.0000216	4.84×10^{-7}
Sludge Residue	0.002	1.47×10^{-8}	1.59×10^{-9}	0.000257	6.12×10^{-6}	1.37×10^{-7}
Earthquake and Building Collapse – Building 371 Vault						
Fluoride Residue	0.000094	9.45×10^{-9}	9.45×10^{-10}	0.000131	3.15×10^{-6}	8.82×10^{-8}
Scrub Alloy	0.000094	4.94×10^{-9}	4.94×10^{-10}	0.0000686	1.65×10^{-6}	4.61×10^{-8}
Alternative 1 Storage Risk per Year						
N/A	N/A	9.14×10^{-8}	9.78×10^{-9}	0.00155	0.0000369	8.53×10^{-7}
Alternative 1 20-Year Storage Risk						
N/A	N/A	1.83×10^{-6}	1.96×10^{-7}	0.0309	0.000738	0.0000171

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable

D.3.4.11.2 Alternative 2 – Processing Without Plutonium Separation

Table D–252 indicates that, with the exception of filter media residue, following processing and packaging under Alternative 2 stored plutonium residue and scrub alloy are not vulnerable to the postulated set of accidents. Filter media residue processed using the blend down technology is vulnerable to the postulated set of accidents because the processed residue is not stored in drummed pipe components. **Table D–253** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the storage of filter media residue following blend down processing and packaging. The associated storage risks are presented in **Table D–254**. As discussed in Section D.3.3.4.1, the annual frequency for the large aircraft crash is in the non-foreseeable range and the accident consequences and risks are not evaluated.

Table D–252 Alternative 2 Storage Accident Consequences

Residue	Building Source Term		Doses				
			MEI (rem)		Population (person-rem)		Worker (rem)
	(grams)	Type	95% Met	50% Met	95% Met	50% Met	50% Met
High Wind Accident – Butler Building							
Filter Media	2.32×10^{-6}	Metal	5.57×10^{-6}	6.03×10^{-7}	0.0974	0.00232	0.0000650
Small Aircraft Crash – Butler Building							
Filter Media	0.00834	Metal	0.0200	0.00217	350	8.34	0.234
Room Fire – Butler Building							
Filter Media	0.00696	Metal	0.0167	0.00181	292	6.96	0.195
Earthquake and Building Collapse – Butler Building							
Filter Media	0.0216	Metal	0.0519	0.00562	908	21.6	0.605

MEI = maximally exposed individual Met = meteorological data

Table D–253 Alternative 2 Storage Accident Risks in Terms of Latent Cancer Fatalities per Year

Residue	Accident Frequency (per yr)	Risks				
		MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
High Wind Accident – Butler Building						
Filter Media	0.00429	1.19×10^{-11}	1.29×10^{-12}	2.09×10^{-7}	4.98×10^{-9}	1.11×10^{-10}
Small Aircraft Crash – Butler Building						
Filter Media	1.29×10^{-6}	1.29×10^{-11}	1.40×10^{-12}	2.26×10^{-7}	5.38×10^{-9}	1.20×10^{-10}
Room Fire – Butler Building						
Filter Media	0.00001	8.35×10^{-11}	9.05×10^{-12}	1.46×10^{-6}	3.48×10^{-8}	7.80×10^{-10}
Earthquake and Building Collapse – Butler Building						
Filter Media	0.002	5.19×10^{-8}	5.62×10^{-9}	0.000908	0.0000216	4.84×10^{-7}
Alternative 2 Storage Risk per Year						
Filter Media	N/A	5.20×10^{-8}	5.63×10^{-9}	0.000910	0.0000217	4.85×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable

D.3.4.11.3 Alternative 3 – Processing With Plutonium Separation

Alternative 3 storage assessments address the following issues:

- Storage after processing with plutonium separation at Rocky Flats,

- Storage at Rocky Flats after preprocessing and/or packaging for offsite processing at the Savannah River Site or the Los Alamos National Laboratory,
- Storage after processing with plutonium separation at the Savannah River Site, and
- Storage after processing with plutonium separation at the Los Alamos National Laboratory.

❒ **Storage After Processing With Plutonium Separation at Rocky Flats—Table D–254** presents a summary of the stored material vulnerability to the postulated set of accidents. **Table D–255** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the storage of residues following processing with plutonium separation and packaging of the product at Rocky Flats. The associated storage risks are presented in **Table D–256**.

Table D–254 Stored Material Location Vulnerability to Postulated Accidents

Accident	*Butler Building*	*Building 371 Vault*
High Wind	Yes	No
Small Aircraft Crash	Yes	No
Room/Vault Fire	Yes	No
Earthquake and Building Collapse	Yes	Yes

Table D–255 Storage Accident Consequences

	Building Source Term		*Doses*				
			MEI (rem)		*Population (person-rem)*		*Worker (rem)*
Residue	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
High Wind Accident – Butler Building							
ER & MSE Salt	1.50×10^{-6}	Salt-O	0.0000211	2.26×10^{-6}	0.391	0.00932	0.000256
DOR Salt	1.55×10^{-6}	Salt-O	0.0000217	2.33×10^{-6}	0.404	0.00962	0.000264
Fluoride	0.000158	Metal-O	0.000190	0.0000206	3.96	0.0950	0.00333
Sludge	0.000212	Metal-O	0.0000254	2.76×10^{-6}	0.530	0.0127	0.000445
Small Aircraft Crash – Butler Building							
ER & MSE Salt	0.0677	Salt-O	0.948	0.102	17,600	420	11.5
DOR Salt	0.0698	Salt-O	0.978	0.105	18,200	433	11.9
Fluoride	0.000238	Metal-O	0.000286	0.0000309	5.95	0.143	0.00500
Sludge	0.00191	Metal-O	0.00229	0.000248	47.7	1.14	0.0401
Room Fire – Butler Building							
DOR Salt	0.0116	Salt-O	0.163	0.0175	3,030	72.2	1.98
Fluoride	0.0000396	Metal-O	0.0000475	5.15×10^{-6}	0.990	0.0238	0.000832
Sludge	0.000318	Metal-O	0.000382	0.0000413	7.95	0.191	0.00668
Earthquake and Building Collapse – Butler Building							
ER & MSE Salt	0.00461	Salt-O	0.0645	0.00691	1,200	28.6	0.783
DOR Salt	0.00115	Salt-O	0.0161	0.00173	300	7.14	0.196

Residue	Building Source Term		Doses				
			MEI (rem)		Population (person-rem)		Worker (rem)
	(grams)	Type	95% Met	50% Met	95% Met	50% Met	50% Met
Fluoride	0.0000928	Metal-O	0.000111	0.0000121	2.32	0.0557	0.00195
Sludge	0.0000232	Metal-O	0.0000278	3.20×10^{-6}	0.580	0.0139	0.000487
Earthquake and Building Collapse – Building 371 Vault							
ER & MSE Salt	0.0618	Salt-O	1.36	0.136	16,100	383	10.5
DOR Salt	0.0144	Salt-O	0.317	0.0317	3,750	89.4	2.45
Combustible	0.00610	Metal-O	0.0110	0.00110	153	3.66	0.128
Fluoride	0.112	Metal-O	0.201	0.0201	2,790	67.0	2.35
Filter Media	0.0863	Metal-O	0.155	0.0155	2,160	51.8	1.81
Sludge	0.0200	Metal-O	0.356	0.0356	4,950	119	4.16
Glass	0.00143	Metal-O	0.00258	0.000258	35.8	0.858	0.0300
Graphite	0.0278	Metal-O	0.0501	0.00501	696	16.7	0.584
Inorganic	0.00499	Metal-O	0.00899	0.000899	125	3.00	0.105

MEI = maximally exposed individual Met = meteorological data DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue Salt-O = salt oxide Metal-O = metal oxide

Table D–256 Storage Accident Risks

Residue	Accident Frequency (per yr)	Risks				
		MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
High Wind Accident – Butler Building						
ER & MSE Salt	0.000112	1.18×10^{-12}	1.26×10^{-13}	2.19×10^{-8}	5.22×10^{-10}	1.15×10^{-11}
DOR Salt	0.0000275	2.99×10^{-13}	3.20×10^{-14}	5.55×10^{-9}	1.32×10^{-10}	2.90×10^{-12}
Fluoride	8.88×10^{-6}	8.44×10^{-13}	9.14×10^{-14}	1.76×10^{-8}	4.22×10^{-10}	1.18×10^{-11}
Sludge	0.0000169	2.15×10^{-13}	2.33×10^{-14}	4.48×10^{-9}	1.07×10^{-10}	3.01×10^{-12}
Small Aircraft Crash – Butler Building						
ER & MSE Salt	3.35×10^{-8}	1.59×10^{-11}	1.70×10^{-12}	2.95×10^{-7}	7.03×10^{-9}	1.54×10^{-10}
DOR Salt	8.25×10^{-9}	4.03×10^{-12}	4.32×10^{-13}	7.49×10^{-8}	1.79×10^{-9}	3.92×10^{-11}
Fluoride	2.66×10^{-9}	3.80×10^{-16}	4.12×10^{-17}	7.91×10^{-12}	1.90×10^{-13}	5.32×10^{-15}
Sludge	5.05×10^{-9}	5.78×10^{-15}	6.26×10^{-16}	1.20×10^{-10}	2.89×10^{-12}	8.09×10^{-14}
Room Fire – Butler Building						
DOR Salt	0.00001	8.15×10^{-10}	8.73×10^{-11}	0.0000151	3.61×10^{-7}	7.92×10^{-9}

Residue	*Accident Frequency (per yr)*	*Risks*				
		MEI (LCF/yr)		*Population (LCF/yr)*		*Worker (LCF/yr)*
		95% Met	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Fluoride	0.00001	2.38×10^{-13}	2.57×10^{-14}	4.95×10^{-9}	1.19×10^{-10}	3.33×10^{-12}
Sludge	0.00001	1.91×10^{-12}	2.07×10^{-13}	3.98×10^{-8}	9.54×10^{-10}	2.67×10^{-11}
Earthquake and Building Collapse – Butler Building						
ER & MSE Salt	0.002	6.45×10^{-8}	6.91×10^{-9}	0.00120	0.0000286	6.27×10^{-7}
DOR Salt	0.002	1.61×10^{-8}	1.73×10^{-9}	0.000300	7.14×10^{-6}	1.57×10^{-7}
Fluoride	0.002	1.11×10^{-10}	1.21×10^{-11}	2.32×10^{-6}	5.57×10^{-8}	1.56×10^{-9}
Sludge	0.002	2.78×10^{-11}	3.02×10^{-12}	5.80×10^{-7}	1.39×10^{-8}	3.90×10^{-10}
Earthquake and Building Collapse – Building 371 Vault						
ER & MSE Salt	0.000094	6.39×10^{-8}	6.39×10^{-9}	0.000755	0.0000180	7.90×10^{-7}
DOR Salt	0.000094	1.49×10^{-8}	1.49×10^{-9}	0.000176	4.20×10^{-6}	1.84×10^{-7}
Combustible	0.000094	5.16×10^{-10}	5.16×10^{-11}	7.17×10^{-6}	1.72×10^{-7}	9.64×10^{-9}
Fluoride	0.000094	9.45×10^{9}	9.45×10^{-10}	0.000131	3.15×10^{-6}	1.76×10^{-7}
Filter Media	0.000094	7.30×10^{-9}	7.30×10^{-10}	0.000101	2.43×10^{-6}	1.36×10^{-7}
Sludge	0.000094	1.68×10^{-8}	1.68×10^{-9}	0.000233	5.58×10^{-6}	3.13×10^{-7}
Glass	0.000094	1.21×10^{-10}	1.21×10^{-11}	1.68×10^{-6}	4.03×10^{-8}	2.26×10^{-9}
Graphite	0.000094	2.35×10^{-9}	2.35×10^{-10}	0.0000327	7.85×10^{-7}	4.39×10^{-8}
Inorganic	0.000094	4.22×10^{-10}	4.22×10^{-11}	5.87×10^{-6}	1.41×10^{-7}	7.89×10^{-9}
Storage Risk per Year						
N/A	N/A	1.96×10^{-7}	2.02×10^{-8}	0.00294	0.0000703	2.45×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable
DOR = direct oxide reduction salt residue ER & MSE = electrorefining and molten salt extraction salt residue

❒ **Storage at Rocky Flats After Preprocessing and/or Repackaging for Offsite Processing—Table D–257** presents a summary of the stored material vulnerability to the postulated set of accidents. **Table D–258** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the storage of residues and scrub alloy following preprocessing and/or packaging at Rocky Flats for processing with plutonium separation at either the Savannah River Site or the Los Alamos National Laboratory. The associated storage risks are presented in **Table D–259**.

Table D–257 Stored Material Location Vulnerability to Postulated Accidents

Accident	*Butler Building*	*Building 371 Vault*
High Wind	No	No
Small Aircraft Crash	No	No
Room/Vault Fire	No	No
Earthquake and Building Collapse	No	Yes

Table D–258 Storage Accident Consequences

	Building Source Term		*Doses*				
			MEI (rem)		*Population (person-rem)*		*Worker (rem)*
Material	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Earthquake and Building Collapse – Building 371 Vault							
Ash	0.0873	Metal-O	0.157	0.0157	2,180	52.4	1.83
ER & MSE Salt	0.0671	Salt-O	1.48	0.148	17,400	416	11.4
DOR Salt	0.00927	Salt-O	0.204	0.0204	2,410	57.5	1.48
Fluoride	0.00272	Metal	0.00980	0.000980	114	2.72	0.0762
Graphite	0.00186	Metal	0.00670	0.000670	78.1	1.86	0.0521
Inorganic	0.000338	Metal	0.00122	0.000122	14.2	0.338	0.00946
Scrub Alloy	0.0000584	Metal-O	0.000105	0.0000105	1.46	0.0350	0.00123

MEI = maximally exposed individual Met = meteorological data DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue Metal-O = metal oxide Salt-O = salt oxide

Table D–259 Storage Accident Risks

	Accident Frequency (per yr)	*Risks*				
		MEI (LCF/yr)		*Population (LCF/yr)*		*Worker (LCF/yr)*
Material		*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Earthquake and Building Collapse – Building 371 Vault						
Ash	0.000094	7.38×10^{-9}	7.38×10^{-10}	0.000103	2.46×10^{-6}	6.89×10^{-8}
ER & MSE Salt	0.000094	6.94×10^{-8}	6.94×10^{-9}	0.000820	0.0000195	4.29×10^{-7}
DOR Salt	0.000094	9.58×10^{-9}	9.58×10^{-10}	0.000113	2.70×10^{-6}	5.92×10^{-8}
Fluoride	0.000094	4.60×10^{-10}	4.60×10^{-11}	5.37×10^{-6}	1.28×10^{-7}	2.86×10^{-9}
Graphite	0.000094	3.15×10^{-10}	3.15×10^{-11}	3.67×10^{-6}	8.74×10^{-8}	1.96×10^{-9}
Inorganic	0.000094	5.71×10^{-11}	5.71×10^{-12}	6.67×10^{-7}	1.59×10^{-8}	3.56×10^{-10}
Scrub Alloy	0.000094	4.94×10^{-12}	4.94×10^{-13}	6.86×10^{-8}	1.65×10^{-9}	4.61×10^{-11}
Storage Risk per Year						
N/A	N/A	8.72×10^{-8}	8.72×10^{-9}	0.00105	0.0000249	5.62×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable
DOR = direct oxide reduction salt residue ER & MSE = electrorefining and molten salt extraction salt residue

❒ **Storage After Processing With Plutonium Separation at the Savannah River Site—Table D–260** presents a summary of the stored material vulnerability to the postulated set of accidents. **Table D–261** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the storage of residues following processing with plutonium separation and packaging of the product at the Savannah River Site F-Canyon or H-Canyon. The product for storage from the F-Canyon will be plutonium metal and plutonium oxide powder from the H-Canyon. The associated storage risks are presented in **Table D–262**.

Table D–260 Stored Material Location Vulnerability to Postulated Accidents

Accident	*APSF Vault*
High Wind	No
Small Aircraft Crash	No
Vault Fire	No
Earthquake and Building Collapse	Yes

Table D–261 Storage Accident Consequences

			Doses				
	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Material	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Earthquake and Building Collapse – APSF Vault							
F-Canyon Product (plutonium metal)	0.000736	Oxide	0.0000368	6.92×10^{-6}	1.47	0.103	0.0125
H-Canyon Product (plutonium oxide powder)	2.00	Oxide	0.0998	0.0188	3,990	280	33.9

MEI = maximally exposed individual Met = meteorological data APSF = Actinide Packaging and Storage Facility

Table D–262 Storage Accident Risks

		Risks				
	Accident Frequency (per yr)	*MEI (LCF/yr)*		*Population (LCF/yr)*		*Worker (LCF/yr)*
Material		*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Earthquake and Building Collapse – APSF Vault						
F-Canyon Product (plutonium metal)	0.00001	1.84×10^{-13}	3.46×10^{-14}	7.36×10^{-9}	5.15×10^{-10}	5.01×10^{-11}
H-Canyon Product (plutonium oxide powder)	0.00001	4.99×10^{-10}	9.38×10^{-11}	0.0000200	1.40×10^{-6}	2.72×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable
APSF = Actinide Packaging and Storage Facility

- **Storage After Processing With Plutonium Separation at the Los Alamos National Laboratory—Table D–263** presents a summary of the stored material vulnerability to the postulated set of accidents. **Table D–264** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the storage of residues following processing with plutonium separation and packaging of the product at the Los Alamos National Laboratory. The associated storage risks are presented in **Table D–265**.

Table D–263 Stored Material Location Vulnerability to Postulated Accidents

Accident	*TA-55 Plutonium Vault*
High Wind	No
Small Aircraft Crash	No
Vault Fire	No
Earthquake and Building Collapse	Yes

Table D–264 Storage Accident Consequences

			Doses				
	Building Source Term		*MEI (rem)*		*Population (person-rem)*		*Worker (rem)*
Material	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Earthquake and Building Collapse – TA-55 Plutonium Vault							
ER & MSE Salt	0.627	Salt-O	23.8	3.07	31,400	3,200	257
DOR Salt	0.149	Salt-O	5.66	0.730	7,440	759	61.0
Earthquake and Building Collapse – TA-55 Waste Storage Area							
ER & MSE Salt	0.00974	Salt-O	0.370	0.0477	487	49.7	3.99

MEI = maximally exposed individual Met = meteorological data TA = technical area
DOR = direct oxide reduction salt residue ER & MSE = electrorefining and molten salt extraction salt residue
Salt-O = salt oxide

Table D–265 Storage Accident Risks

		Risks				
		MEI (LCF/yr)		*Population (LCF/yr)*		*Worker (LCF/yr)*
Residue	*Accident Frequency (per yr)*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
Earthquake and Building Collapse – TA-55 Plutonium Vault						
ER & MSE Salt	0.0000190	4.53×10^{-7}	2.92×10^{-8}	0.000298	0.0000304	3.91×10^{-6}
DOR Salt	0.0000190	1.08×10^{-7}	6.93×10^{-9}	0.0000707	7.21×10^{-6}	9.28×10^{-7}
Earthquake and Building Collapse – TA-55 Waste Storage Area						
ER & MSE Salt	0.0000190	7.03×10^{-9}	4.53×10^{-10}	4.63×10^{-6}	4.72×10^{-7}	6.07×10^{-8}
Storage Risk per Year						
N/A	N/A	5.67×10^{-7}	3.66×10^{-8}	0.000373	0.0000381	4.90×10^{-6}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable
TA = technical area DOR = direct oxide reduction salt residue
ER & MSE = electrorefining and molten salt extraction salt residue

D.3.4.11.4 Alternative 4 – Combination of Processing Technologies

Table D–266 presents a summary of the stored residue vulnerability to the postulated set of accidents. **Table D–267** summarizes the consequences to the maximally exposed individual, the public, and workers resulting from the accidental releases associated with the storage of residues following processing and packaging using Alternative 4 processing technologies. The storage risks associated with Alternative 4 are presented in **Table D–268**.

Table D–266 Stored Material Location Vulnerability to Postulated Accidents

Accident	*Butler Building*
High Wind	Yes
Small Aircraft Crash	Yes
Room Fire	Yes
Earthquake and Building Collapse	Yes

Table D–267 Alternative 4 Storage Accident Consequences

	Building Source Term		*Doses*				
			MEI (rem)		*Population (person-rem)*		*Worker (rem)*
Material	*(grams)*	*Type*	*95% Met*	*50% Met*	*95% Met*	*50% Met*	*50% Met*
High Wind Accident							
Combustible Residue	2.32×10^{-6}	Metal	5.57×10^{-6}	6.03×10^{-7}	0.0974	0.00232	0.0000650
Filter Media Residue[a]	2.32×10^{-6}	Metal	5.57×10^{-6}	6.03×10^{-7}	0.0974	0.00232	0.0000650
Sludge Residue[b]	0.0000928	Metal	0.000223	0.0000241	3.90	0.0928	0.00260
Small Aircraft Crash							
Combustible Residue	0.0695	Metal	0.167	0.0181	2,920	69.5	1.95
Filter Media Residue[a]	0.00834	Metal	0.0200	0.00217	350	8.34	0.234
Sludge Residue[b]	0.00834	Metal	0.0200	0.00217	350	8.34	0.234
Room Fire							
Combustible Residue	0.0116	Metal	0.0278	0.00302	487	11.6	0.325
Filter Media Residue[a]	0.00696	Metal	0.0167	0.00181	292	6.96	0.195
Sludge Residue[b]	0.00278	Metal	0.00668	0.000724	117	2.78	0.0780
Earthquake and Building Collapse							
Combustible Residue	0.00411	Metal	0.00987	0.00107	173	4.11	0.115
Filter Media Residue[a]	0.0179	Metal	0.0431	0.00467	754	17.9	0.503
Sludge Residue[b]	0.00589	Metal	0.0141	0.00153	247	5.89	0.165

MEI = maximally exposed individual Met = meteorological data

[a] Ful Flo filter media IDC 331 is excluded from Alternative 4.

[b] IDCs 089, 099, and 332 are excluded from Alternative 4.

Table D–268 Alternative 4 Storage Accident Risks in Terms of Latent Cancer Fatalities per Year

Material	Accident Frequency (per yr)	Risks				
		MEI (LCF/yr)		Population (LCF/yr)		Worker (LCF/yr)
		95% Met	50% Met	95% Met	50% Met	50% Met
High Wind Accident						
Combustible Residue	0.000813	2.26×10^{-12}	2.45×10^{-13}	3.96×10^{-8}	9.43×10^{-8}	2.11×10^{-11}
Filter Media Residue[a]	0.00421	9.91×10^{-12}	1.07×10^{-12}	1.73×10^{-7}	4.13×10^{-9}	9.25×10^{-11}
Sludge Residue[b]	0.000972	1.08×10^{-10}	1.17×10^{-11}	1.89×10^{-6}	4.51×10^{-8}	1.01×10^{-9}
Small Aircraft Crash						
Combustible Residue	2.44×10^{-7}	2.03×10^{-11}	2.20×10^{-12}	3.56×10^{-7}	8.48×10^{-9}	1.90×10^{-10}
Filter Media Residue[a]	1.26×10^{-6}	1.07×10^{-11}	1.16×10^{-12}	1.87×10^{-7}	4.46×10^{-9}	9.99×10^{-12}
Sludge Residue[b]	2.91×10^{-7}	2.91×10^{-12}	3.16×10^{-13}	5.10×10^{-8}	1.21×10^{-9}	2.72×10^{-11}
Room Fire						
Combustible Residue	0.00001	1.39×10^{-10}	1.51×10^{-11}	2.44×10^{-6}	5.80×10^{-8}	1.30×10^{-9}
Filter Media Residue[a]	0.00001	8.35×10-11	9.05×10^{-12}	1.46×10^{-6}	3.48×10^{-8}	7.80×10^{-10}
Sludge Residue[b]	0.00001	3.34×10^{-11}	3.62×10^{-12}	5.85×10^{-7}	1.39×10^{-8}	3.12×10^{-10}
Earthquake and Building Collapse						
Combustible Residue	0.002	9.87×10^{-9}	1.07×10^{-9}	0.000173	4.11×10^{-6}	9.21×10^{-8}
Filter Media Residue[a]	0.002	4.31×10^{-8}	4.67×10^{-9}	0.000754	0.0000179	4.02×10^{-7}
Sludge Residue[b]	0.002	1.41×10^{-8}	1.53×10^{-9}	0.000247	5.89×10^{-6}	1.32×10^{-7}
Alternative 4 Storage Risk per Year						
N/A	N/A	6.75×10^{-8}	7.31×10^{-9}	0.00118	0.0000281	6.30×10^{-7}

MEI = maximally exposed individual Met = meteorological data LCF = latent cancer fatality N/A = not applicable

[a] Ful Flo filter media IDC 331 is excluded from Alternative 4.

[b] IDCs 089, 098, and 332 are excluded from Alternative 4.

D.3.5 Secondary Impacts of Accidents

The primary impact of accidents are measured in terms of public and worker exposures to radiation and toxic chemicals. The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be lowered; recreational areas may be closed; industrial parks may suffer economic losses during shutdown for decontamination; historical sites may have to be closed to visitors; and the endangered species may move closer to extinction.

Accidents during the processing of salts at Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory were selected to assess secondary impacts of accidents. Doses to the public maximally exposed individual at the site boundary, attributable to ground contamination from the highest consequence accident, were calculated. In all cases, the dose to the maximally exposed individual at the site boundary attributable to ground contamination was less than 1 mrem per year. The GENII computer code model for the maximally exposed individual assumes that the maximally exposed individual is exposed to soil contamination for 0.7 years. The soil contamination level at the site boundary was estimated based on the maximally exposed

individual dose. The soil contamination level at the site boundaries for Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory was less than 1 mrem per year.

D.4 IMPACTS OF EXPOSURES TO HAZARDOUS CHEMICALS ON HUMAN HEALTH

The potential impacts of exposure to hazardous chemicals released to the atmosphere as a result of the processing of plutonium residues and scrub alloy were evaluated for the routine operation of processing facilities.

The receptors considered in these evaluations include the offsite population living within an 80-km (50-mi) radius of the sites and noninvolved workers located onsite at Rocky Flats and the Savannah River Site. Impacts were also evaluated for the maximally exposed individual member of the offsite population. The maximally exposed individual is the hypothetical person in the population who has the highest potential exposure. Impacts of exposures to hazardous chemicals for workers directly involved in processing plutonium residues and scrub alloy were not quantitatively evaluated because the use of personal protective equipment and engineering process controls will limit their exposure to levels within applicable Occupational Safety and Health Administration Permissible Exposure Limits or American Conference of Governmental Industrial Hygienists Threshold Limit Values.

As a result of releases from routine processing facility operations, receptors are expected to be potentially exposed to concentrations of hazardous chemicals that are below those that could cause acutely toxic health effects. Acutely toxic health effects generally result from short-term exposure to relatively high concentrations of contaminants, such as those that may be encountered during facility accidents. Long-term exposure to relatively lower concentrations of hazardous chemicals can produce adverse chronic health effects that include both carcinogenic and noncarcinogenic effects. The health effect endpoints evaluated in this analysis include excess incidences of latent cancers for carcinogenic chemicals and a spectrum of chemical-specific noncancer health effects (primarily respiratory system toxicity) for noncarcinogens.

D.4.1 Methodology

Estimates of airborne concentrations of hazardous chemicals were developed using the Industrial Source Complex (ISC) air dispersion model. This model was developed by the EPA for regulatory air dispersion modeling applications. ISC3 is the most recent version of the model and is approved for use for a wide variety of emission sources and conditions. The Industrial Source Complex model estimates atmospheric concentrations based on the airborne emissions from the processing facility for each block in a circular grid comprising 16 directional sectors (e.g., north, north-northeast, northeast) at radial distances out to 80 km (50 mi) from the point of release, producing a distribution of atmospheric concentrations. The maximally exposed individual is located in the block with the highest estimated concentration.

The long-term version of the model (ISCLT3) was run for Rocky Flats to estimate annual onsite and offsite concentrations in order to determine long-term (chronic) exposure and to assess compliance with annual ambient air quality standards. The short-term version of the model (ISCST3) was run for Savannah River to estimate annual concentrations in order to determine long-term exposure and to estimate both annual and short-term (30-day, 24-hour, and 12-hour) offsite concentrations to assess compliance with corresponding ambient air quality standards (EPA 1995b, EPA 1995c). The meteorological data used as input to the models include short-term surface and upper data and joint frequency (STAR) data. Onsite surface and joint frequency data for Rocky Flats and the Savannah River Site used as input to the models were obtained from DOE. Additional information about the processing of model input data can be found in the technical support document (SAIC 1998b).

This EIS estimates noncancer health risks by comparing modeled air concentrations of contaminants produced by ISC3 to EPA Reference Concentrations (RfCs), as published in the Integrated Risk Information System (IRIS).

For each noncarcinogenic chemical, potential health risks are estimated by dividing the estimated airborne concentration by the chemical-specific RfC value to obtain a noncancer hazard quotient:

Noncancer Hazard Quotient = Air Concentration /RfC

Note that the modeled annual airborne concentrations produced by ISC are converted to daily equivalents for comparison to RfC values.

Reference Concentrations are estimates, with uncertainty spanning perhaps an order of magnitude, of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. Hazard Quotients are calculated for each hazardous chemical to which receptors may be exposed. Hazard Quotients for each chemical are summed to generate a Hazard Index. For example, **Table D–269** lists the Hazard Quotient values that were summed to develop the Hazard Index estimates for the Purex and mediated electrochemical oxidation processes at the Savannah River Site. The Hazard Index is an estimate of the total noncancer toxicity from exposure to hazardous chemicals. According to EPA risk assessment guidelines (EPA 1989), if the Hazard Index value is less than or equal to 1.0, the exposure is unlikely to produce adverse toxic effects. If the Hazard Index exceeds 1.0, adverse noncancer health effects may result from the exposure.

For carcinogenic chemicals, risk is estimated by the following equation:

$$\text{Risk} = \text{CA} \times \text{URF}$$

where

Risk = a unitless probability of cancer incidence
CA = contaminant concentration in air (in $\mu g/m^3$)
URF = cancer inhalation unit risk factor (in units of cancers per $\mu g/m^3$)

CA is estimated by multiplying the output of the ISC3 model by the process duration to obtain estimates of total airborne exposure for each process.

Cancer unit risk factors are used in risk assessments to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen.

The proposed action processes involve emissions of carcinogenic chemicals only at Rocky Flats. For the Rocky Flats region of influence, offsite population cancer incidences were estimated by multiplying the estimated cancer incidences for each radial sector by the population living within that sector.

D.4.2 Assumptions

The airborne pathway is assumed to be the principal exposure route by which the offsite public and noninvolved workers are exposed to hazardous chemicals released from processing facilities. Under routine operating conditions, hazardous chemicals are released from processing facilities only to the atmosphere; no releases are assumed to occur to surface water, groundwater, or soil. The noninvolved worker is assumed to be located onsite downwind of the release source at a distance corresponding to the point of maximum exposure.

Table D–269 Savannah River Site Noncancer Risk Estimates (Hazard Quotient and Hazard Index Values)

Chemical	*Purex Process*										*Mediated Electrochemical Oxidation Process*					
	Ash Residues		*Fluoride Residues*		*Existing Scrub Alloy*		*Salt Scrub Alloy*		*Sand, Slag, and Crucible Residue*		*Ash Residue*		*Graphite Residues*		*Inorganic Residues*	
	Worker HQ	*Offsite MEI HQ*	*Worker HQ*	*Offsite MEI HQ*	*Worker HQ*	*Offsite MEI HQ*	*Worker HQ*	*Offsite MEI HQ*	*Worker HQ*	*Offsite MEI HQ*	*Worker HQ*	*Offsite MEI HQ*	*Worker HQ*	*Offsite MEI HQ*	*Worker HQ*	*Offsite MEI HQ*
Phosphoric acid	2×10^{-8}	1×10^{-9}	2×10^{-8}	1×10^{-9}	2×10^{-8}	2×10^{-9}	2×10^{-8}	2×10^{-9}	2×10^{-8}	2×10^{-9}	7×10^{-9}	5×10^{-10}	2×10^{-8}	2×10^{-9}	2×10^{-8}	2×10^{-9}
Ammonium nitrate	2×10^{-9}	1×10^{-10}	2×10^{-9}	1×10^{-10}	4×10^{-9}	3×10^{-10}	4×10^{-9}	3×10^{-10}	4×10^{-9}	3×10^{-10}	1×10^{-9}	8×10^{-11}	4×10^{-9}	3×10^{-10}	4×10^{-9}	3×10^{-10}
Hazard Index [a]	2×10^{-8}	1×10^{-9}	2×10^{-8}	1×10^{-9}	2×10^{-8}	2×10^{-9}	2×10^{-8}	2×10^{-9}	2×10^{-8}	2×10^{-9}	8×10^{-9}	6×10^{-10}	2×10^{-8}	2×10^{-9}	2×10^{-8}	2×10^{-9}

MEI = maximally exposed individual HQ = hazard quotient

[a] Sum of Hazard Quotients

No synergistic or antagonistic effects are assumed to occur from exposure to the hazardous chemicals released from processing facilities. Synergistic effects among released contaminants may result in adverse health effects that are greater than those estimated, whereas, antagonistic effects among released chemicals may result in less severe health effects than those estimated.

The source term that was used for phosphoric acid was reported as phosphoric acid/tributyl phosphate. Since inhalation toxicity information is not available for tributyl phosphate, all of the source term was assumed to be phosphoric acid. This assumption produces conservative estimates of Hazard Quotients for this compound and for Hazard Index estimates developed using these Hazard Quotients.

In a similar manner, all of the source term for ammonium nitrate was assumed to be ammonia. This assumption also produces conservative estimates of the Hazard Quotients for this compound and for the Hazard Index estimates produced using these Hazard Quotients.

D.4.3 Hazardous Chemical Source Terms

Emissions from the proposed action processes at Rocky Flats and the Savannah River Site were modeled so that individual source contributions to potential receptors could be estimated. At Rocky Flats, all hazardous chemicals were released from the Building 371 stack. At the Savannah River Site, emissions were from one stack located in the F-Area. To develop conservative estimates of exposure, all modeled emissions assumed no plume rise. The proposed action processes at the Los Alamos National Laboratory do not involve emissions of hazardous chemicals; therefore, contaminant ambient air concentrations were not modeled for this site.

The hazardous chemical source terms for the processes proposed for Rocky Flats are presented in **Table D–270**. **Table D–271** presents the source term data for the Savannah River Site.

D.4.4 Health Risks from Routine Operation Chemical Exposures

The results of the health risk analyses for routine operation chemical exposures are presented in Chapter 4 of this EIS. As discussed in Section 4.1, not all of the chemicals potentially released from the proposed action processing at Rocky Flats and the Savannah River Site were used to estimate health risks. Some of the chemicals are inert (e.g., argon) some are innocuous (e.g., calcium and calcium oxide), and some are toxic only by ingestion exposure (e.g., fluorides). The toxicity of some chemicals (e.g., n-dodecane and tributyl phosphate) is not well characterized, and some chemicals are addressed as air pollutants in Section 4.12 (e.g., volatile organic compounds, nitrogen oxide gases).

D.4.5 Facility Accident Chemical Exposure Impacts

The potential health risks resulting from exposure to hazardous chemicals released as a result of accidents at processing facilities were not quantitatively evaluated in this EIS. The impacts of chemical exposures from relevant facility accidents at Building 371 at Rocky Flats and at the F-Area separation facilities of the Savannah River Site have been evaluated in other investigations, such as the *Rocky Flats Draft Cumulative Impacts Document (DOE 1997a), the Rocky Flats Environmental Technology Site, Basis for Interim Operation, Building 371/374 complex* (KHC 1997a) and the Savannah River Site *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995a). The results of these analyses, which are incorporated by reference, indicate that the consequences for the most exposed member of the offsite population and onsite noninvolved workers would be low and could be mitigated by emergency response actions. Workers involved in the facility processes may experience serious injury or fatalities as a result of their proximity to the release

sources. The impacts of chemical releases as a result of accidents at the proposed plutonium residue and scrub alloy processing facilities at Building 371 and the F-Area are expected to be bounded by the impacts estimated

Table D–270 Chemical Emissions from the Processing of Plutonium Residues and Scrub Alloy at Rocky Flats

	Process Emissions (kg/process duration)										
	Sonic Washing Process		Thermal Desorption Process	CCO Process	Acid Dissolution Process		Mediated Electrochemical Oxidation Process				
Chemicals Released [a]	Filter Media Residues	Combustible Residues	Combustible Residues	Combustible Residues	Sludge Residues	Fluoride Residues	Inorganic Residues	Filter Media Residues	Graphite Residues	Raschig Ring Residues	Combustible Residues
Carbon Tetrachloride	1	1	1	–	–	–	–	–	–	–	–
Hydrochloric Acid	–	–	–	0.04	–	–	–	–	–	–	–
Nitrogen Oxide Gases	–	–	–	–	0.3	0.2	2	2.9	5	0.3	2.2

CCO = catalytic chemical oxidation

[a] In addition to these chemicals, several of the proposed action processes at Rocky Flats would release various amounts of water vapor, carbon dioxide, and oxygen. Emissions of these compounds were not modeled in this EIS because their contribution to concentrations in ambient air would be negligible.

Table D–271 Chemical Emissions from the Processing of Plutonium Residues and Scrub Alloy at the Savannah River Site

	Process Emissions (tons/batch)Chemicals							
	Purex Process					Mediated Electrochemical Oxidation Process		
Released	Ash Residues	Fluoride Residues	Existing Scrub Alloy	Salt Scrub Alloy	SSC Residues	Ash Residues	Graphite Residues	Inorganic Residues
Nitric Acid	0.029	0.029	0.0387	0.0387	0.0387	0.0114	0.0449	0.0483
Nitrogen Oxide Gases	0.0824	0.0824	0.1098	0.1098	0.1098	0.0324	0.0001	0.1373
Nitrous Oxide	0.0005	0.0005	0.0007	0.0007	0.0007	0.0002	0.0008	0.0009
Phosphoric Acid/Tributyl Phosphate	0.00008	0.00008	0.0001	0.0001	0.0001	0.00003	0.0001	0.0001
VOCs	0.0033	0.0033	0.0045	0.0045	0.0045	0.0013	0.0052	0.0056
Ammonium Nitrate	0.0001	0.0001	0.0002	0.0002	0.0002	0.00005	0.0002	0.0002
Hydrogen Fluoride	0.00001	0.00002	0.000005	0.000005	0.000005	0.0014	0	0
Argon	0.00007	0.00007	0.0002	0.0002	0.0001	0.00007	0.00007	0.00007
Calcium	0.000005	0.000005	0.00002	0.00002	0.00001	0.000005	0.000005	0.000005
Calcium Fluoride	0.00002	0.00002	0.00005	0.00005	0.00003	0.00002	0.00002	0.00002
Calcium Oxide	0.000004	0.000004	0.00001	0.00001	0.000008	0.000004	0.000004	0.000004
N-Dodecane	0.000003	0.000004	0.00001	0.00001	0.000007	0.000003	0.000003	0.000003

SSC = sand, slag, and crucible VOCs = volatile organic compounds

in these other investigations. These analyses are representative of potential chemical accident risks for the proposed actions because they address the same or similar facilities using similar chemicals in relevant scenarios. Because chemical inventories for the H-Area separation facilities of the Savannah River Site are similar to those estimated for the F-Area, potential impacts also are expected to be similar. For example, these analyses estimate the airborne concentrations of hazardous chemical releases from a number of different accident scenarios. Potential human health effects are evaluated by comparing these estimated airborne concentrations to community exposure guidelines known as Emergency Response Planning Guidelines (ERPGs) developed by the American Industrial Hygiene Association (AIHA). ERPGs are defined as follows:

- ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or perceiving a clearly defined objectionable odor.
- ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

The results of selected analyses for chemicals and facilities common to the proposed action processing of plutonium residues and scrub alloy are summarized in **Table D–272** below.

Table D–272 Impacts of Nitric Acid Storage Tank Release at Rocky Flats Building 371/374*

		Worst Case Meteorology	Average Case Meteorology
Involved Worker	Parts per million (ppm) concentration	141	46
	Level of Concern	>ERPG-3	>ERPG-3
	Potential Health Effects	life threatening	life threatening
Noninvolved Worker	Parts per million (ppm) concentration	18	4.2
	Level of Concern	>ERPG-2	>ERPG-1
	Potential Health Effects	Irreversible	Mild, transient
Offsite Maximally Exposed Individual (MEI)	Parts per million (ppm) concentration	0.1	0.02
	Level of Concern	<ERPG-1	<ERPG-1
	Potential Health Effects	None	None

*From *Rocky Flats Cumulative Impacts Document* (DOE 1997a). Location of offsite MEI is 1580 meters.

At Rocky Flats, the estimated airborne concentrations of nitric acid at 30 meters following release from the storage tank exceed the ERPG-3 guideline of 30 parts per million (ppm), and are potentially life threatening to the involved worker. For the noninvolved worker, the 18 ppm concentration exceeds the ERPG-2 guideline of 15 ppm, which suggests potential for irreversible health effects if exposures are experienced for up to one hour without evacuation or other emergency response action. The 4 ppm concentration exceeds the ERPG-1 guideline of 2 ppm, which suggests potential for reversible adverse health effects. For the offsite MEI, the estimated airborne concentrations are less than the ERPG-1 guideline, which suggests that the offsite public should not experience any adverse health effects as a result of the release (DOE 1997a).

Table D–273 Impacts of Potential Nonseismic Initiated Releases of Hazardous Chemicals in F-Area of the Savannah River Site*

Chemical	Noninvolved Worker (640 m)	Offsite MEI (site boundary)	ERPG-1	ERPG-2	ERPG-3
Hydrochloric acid	0.0063	0.000085	4.5	30	150
Hydrofluoric acid	220	2.9	4	16	41
Nitric acid	14	3.6	5.2	39	77

*From *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995b). Concentrations are in units of milligrams per cubic meter.

Table D–274 Impacts of Potential Seismic Initiated Releases of Hazardous Chemicals in F-Area of the Savannah River Site*

Chemical	Noninvolved Worker (640 m)	Offsite MEI (site boundary)	ERPG-1	ERPG-2	ERPG-3
Hydrochloric acid	0.019	0.00026	4.5	30	150
Hydrofluoric acid	220	2.9	4	16	41
Nitric acid	390	14	5.2	39	77

*From *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995b). Concentrations are in units of milligrams per cubic meter.

Table D–275 Impacts of Potential Nonseismic Initiated Releases of Hazardous Chemicals in H-Area of the Savannah River Site*

Chemical	Noninvolved Worker (640 m)	Offsite MEI (site boundary)	ERPG-1	ERPG-2	ERPG-3
Hydrochloric acid	0.00050	5.7×10^{-6}	4.5	30	150
Hydrofluoric acid	0.00043	4.9×10^{-6}	4	16	41
Nitric acid	95	1.9	5.2	39	77

*From *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995b). Concentrations are in units of milligrams per cubic meter.

Table D–276 Impacts of Potential Seismic Initiated Releases of Hazardous Chemicals in H-Area of the Savannah River Site*

Chemical	Noninvolved Worker (640 m)	Offsite MEI (site boundary)	ERPG-1	ERPG-2	ERPG-3
Hydrochloric acid	0.0021	0.000024	4.5	30	150
Hydrofluoric acid	0.00067	7.6×10^{-6}	4	16	41
Nitric acid	230	5.7	5.2	39	77

*From *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995b). Concentrations are in units of milligrams per cubic meter.

At the Savannah River Site, accidental releases of hazardous chemicals in F-Area were estimated to exceed the ERPG-3 guideline for noninvolved workers for hydrofluoric acid and the ERPG-1 guideline for nitric acid following nonseismic-initiated accidents, and the ERPG-3 guideline concentrations for both chemicals following seismic-initiated releases **(Tables D–273 and D–274)**. For H-Area accidents, nitric acid concentrations were estimated to exceed the ERPG-3 guideline concentration for noninvolved workers following nonseismic-initiated events, and ERPG-3 and ERPG-1 guidelines for noninvolved workers and offsite MEI, respectively, following seismic-initiated events **(Tables D–275 and D–276)**. No long-term or life threatening health effects are expected for noninvolved workers under these scenarios because individuals could be notified and evacuated to safe locations within one hour of an inadvertent release. Some individuals could experience significant short-term health effects, such as burning of the lungs and skin irritation. For involved workers, there is a potential for serious injury or fatality because the high airborne concentrations expected at locations close to the point of release might hinder emergency response actions (DOE 1995b).

At Los Alamos National Laboratory, no hazardous chemicals are used in the proposed distillation of pyrochemical salts, and only relatively small amounts of hydrochloric acid are used in the proposed water leach and acid dissolution processing of direct oxide reduction pyrochemical salts. Therefore, the potential impacts of chemical exposures from facility accidents at this site were not quantitatively evaluated in this EIS. Additional information about chemical accidents is presented in the *Draft Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory* (LANL 1998).

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APPENDIX E
EVALUATION OF HUMAN HEALTH EFFECTS OF OVERLAND TRANSPORTATION

E.1 INTRODUCTION

The overland transportation of any commodity involves a risk to both transportation crew members and members of the public. This risk results directly from transportation-related accidents and indirectly from the increased levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive waste, can pose an additional risk due to the unique nature of the material itself. In order to permit a complete appraisal of the environmental impacts of the proposed action and alternatives, the human health risks associated with the overland transportation of plutonium residues and scrub alloy have been assessed.

This appendix provides an overview of the approach used to assess the human health risks that may result from the overland transportation. The appendix includes discussion of the scope of the assessment, analytical methods used for the risk assessment (i.e., computer models), important assessment assumptions, and determination of potential transportation routes. It also presents the results of the assessment. In addition, to aid in the understanding and interpretation of the results, specific areas of uncertainty are described, with an emphasis on how the uncertainties may affect comparisons of the alternatives.

The approach used in this appendix is modeled after that used in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a). That environmental impact statement (EIS) did not perform as detailed of analysis of the specific actions taken for plutonium residues and scrub alloys because of the breadth necessary to analyze the entire plutonium disposition program. Nevertheless, the fundamental assumptions used in this analysis are consistent with those used in that EIS, and the same computer codes and generic release and accident data are used.

The risk assessment results are presented in this appendix in terms of "per-shipment" risk factors, as well as for the total risks associated with each material. Per-shipment risk factors provide an estimate of the risk from a single plutonium residue or scrub alloy shipment between the Rocky Flats Environmental Technology Site (Rocky Flats) and the interim management sites. The total risks for a given alternative are found by multiplying the expected number of shipments by the appropriate per-shipment risk factors.

E.2 SCOPE OF ASSESSMENT

The scope of the overland transportation human health risk assessment, including the alternatives and options, transportation activities, potential radiological and nonradiological impacts, and transportation modes considered, is described below. Additional details of the assessment are provided in the remaining sections of the appendix.

- **Proposed Action and Alternatives—**The transportation risk assessment conducted for this EIS estimates the human health risks associated with the transportation of plutonium residues and scrub alloy for a number of management alternatives.

- **Transportation-Related Activities—**The transportation risk assessment is limited to estimating the human health risks incurred during the overland transportation for each alternative. The risks to workers or to the public during loading, unloading, and handling prior to or after shipment are not included in the overland transportation assessment, but are addressed in Appendix D of this EIS. Similarly, the transportation risk assessment does not address possible impacts from increased transportation levels on local traffic flow, noise levels, or infrastructure.

- **Radiological Impacts—**For each alternative, radiological risks (i.e., those risks that result from the radioactive nature of the plutonium residues and scrub alloy) are assessed for both incident-free (i.e., normal) and accident transportation conditions. The radiological risk associated with incident-free transportation conditions would result from the potential exposure of people to external radiation in the vicinity of a loaded shipment. The radiological risk from transportation accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people through multiple exposure pathways (i.e., exposure to contaminated ground or air, or ingestion of contaminated food).

  All radiologically-related impacts are calculated in terms of committed dose and associated health effects in the exposed populations. The radiation dose calculated is the total effective dose equivalent (NRC 1998a), which is the sum of the effective dose equivalent from external radiation exposure and the 50-year committed effective dose equivalent from internal radiation exposure. Radiation doses are presented in units of roentgen equivalent man (rem) for individuals and person-rem for collective populations. The impacts are further expressed as health risks in terms of latent cancer fatalities and cancer incidence in exposed populations. The health risk conversion factors (expected health effects per dose absorbed) were derived from *International Commission on Radiological Protection Publication 60* (ICRP 1991).

- **Nonradiological Impacts—**In addition to the radiological risks posed by overland transportation activities, vehicle-related risks are also assessed for nonradiological causes (i.e., related to the transport vehicles and not the radioactive cargo) for the same transportation routes. The nonradiological transportation risks are independent of the radioactive nature of the cargo and would be incurred for similar shipments of any commodity. The nonradiological risks are assessed for both incident-free and accident conditions. Nonradiological risks during incident-free transportation conditions would be caused by potential exposure to increased vehicle exhaust emissions. The nonradiological accident risk refers to the potential occurrence of transportation accidents that directly result in fatalities unrelated to the shipment cargo. State-specific transportation fatality rates are used in the assessment. Nonradiological risks are presented in terms of estimated fatalities.

- **Transportation Modes—**All shipments have been assumed to take place by truck transportation modes.

- **Receptors—**Transportation-related risks are calculated and presented separately for workers and members of the general public. The workers considered are truck crew members involved in the actual overland transportation. The general public includes all persons who could be exposed to a shipment while it is moving or stopped en route. Potential risks are estimated for the collective populations of exposed people, as well as for the hypothetical maximally exposed individual. The collective population risk is a measure of the radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk is used as the primary means of comparing various alternatives.

Two other DOE EISs cover transportation activities related to the disposition of plutonium residue and scrub alloy, but outside the scope of this EIS. The *Surplus Plutonium Disposition Draft EIS* covers the disposition of plutonium that may be separated from residues and scrub alloy (DOE 1998). The second

EIS, the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental EIS* (DOE 1997), known as WIPP SEIS-II, includes the environmental impacts of shipping transuranic wastes to the Waste Isolation Pilot Plant (WIPP). Appendix E of the WIPP SEIS-II gives the impacts on a per shipment basis, of transportation from Rocky Flats, Los Alamos National Laboratory, and the Savannah River Site to WIPP.

E.3 PACKAGING AND REPRESENTATIVE SHIPMENT CONFIGURATIONS

Regulations that govern the transportation of radioactive materials are designed to protect the public from the potential loss or dispersal of radioactive materials as well as from routine radiation doses during transit. The primary regulatory approach to promote safety is through the specification of standards for the packaging of radioactive materials. Because packaging represents the primary barrier between the radioactive material being transported and radiation exposure to the public and the environment, packaging requirements are an important consideration for the transportation risk assessment. Regulatory packaging requirements are discussed briefly below and in Chapter 5. In addition, the representative packaging and shipment configurations assumed for this EIS are described.

E.3.1 Packaging Overview

Although several Federal and State organizations are involved in the regulation of radioactive waste transportation, primary regulatory responsibility resides with the U.S. Department of Transportation and the U.S. Nuclear Regulatory Commission. All transportation activities must take place in accordance with the applicable regulations of these agencies specified in 49 Code of Federal Regulations (CFR) Part 173 (DOT 1992a) and 10 CFR Part 71 (NRC 1998b).

Transportation packaging for small quantities of radioactive materials must be designed, constructed, and maintained to contain and shield their contents during normal transport conditions. For large quantities and for more highly radioactive material, such as spent nuclear fuel or plutonium, they must contain and shield their contents in the event of severe accident conditions. The type of packaging used is determined by the total radioactive hazard presented by the material within the packaging. Four basic types of packaging are used: Excepted, Industrial, Type A, and Type B. Another packaging option, Strong, Tight, is still available for some domestic shipments.

Excepted packagings are limited to transporting materials with extremely low levels of radioactivity. Industrial packagings are used to transport materials that, because of their low concentration of radioactive materials, present a limited hazard to the public and the environment. Type A packagings are designed to protect and retain their contents under normal transport conditions and must maintain sufficient shielding to limit radiation exposure to handling personnel. These packagings are used to transport radioactive materials with higher concentrations or amounts of radioactivity than excepted or industrial packagings. Strong, Tight packagings are used in the United States for shipment of certain materials with low levels of radioactivity, such as natural uranium and rubble from the decommissioning of nuclear reactors.

The transportation of highway-route controlled quantities of plutonium (more than a few grams, depending on activity level) requires the use of Type B packaging. In addition to meeting the standards for Type A packaging, Type B packaging must provide a high degree of assurance that even in severe accidents the integrity of the package will be maintained with essentially no loss of the radioactive contents or serious impairment of the shielding capability. Type B packaging must be shown by test or analysis to withstand a series of accident conditions specified in 10 CFR Part 71 (NRC 1998b). The conditions were developed to simulate severe accident conditions, including impact, puncture, fire, and water immersion.

Beyond meeting U.S. Department of Transportation standards showing it can withstand normal conditions of transport without loss or dispersal of its radioactive contents or allowance of significant radiation fields, a Type B packaging must meet the 10 CFR Part 71 requirements administered by the U.S. Nuclear Regulatory Commission (NRC 1998b). The complete sequence of conditions is listed below:

- **Free-Drop—**A 9-meter (m) (30-foot [ft]) free-drop onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage to the package is expected.

- **Puncture—**A 1-m (40-inch [in]) drop onto the upper end of a 15-centimeter (cm) (6-in) diameter solid, vertical, cylindrical, mild steel bar (at least 20 cm [8 in] long) mounted on an essentially unyielding, horizontal surface.

- **Thermal—**Exposure to a heat flux of no less than that of a thermal radiation environment of 800 degrees Celsius (°C) (1,475 degrees Fahrenheit [°F]) with an emissivity coefficient of at least 0.9 for a period of 30 minutes.

- **Water Immersion—**A separate, undamaged package specimen is subjected to water pressure equivalent to immersion under a head of water of at least 15 m (50 ft) for no less than 8 hours.

Effective April 1, 1996, 10 CFR Part 71 has been revised to require an additional immersion condition in 200 m (660 ft) of water for Type B casks designed to contain material with activity levels greater than one million curies (Ci) (NRC 1998b). Containers used for shipping plutonium residue and scrub alloy will not necessarily be subject to this test because they will contain much less than one million curies. The packaging may also be required to withstand the crush condition if it is considered a light-weight, low-density package as most drum-type packages are. The crush test consists of dropping a 500-kilogram (kg) (100-pound [lb]) steel plate from 9 m (30 ft) onto the package, which is resting on an essentially unyielding surface.

Additional restrictions apply to package surface contamination levels, but these restrictions are not important for the transportation radiological risk assessment. For risk assessment purposes, it is important to note that all packaging of a given type is designed to meet the same performance criteria. Therefore, two different Type B designs would be expected to perform similarly during incident-free and accident transportation conditions. The specific containers selected, however, will determine the total number of shipments necessary to transport a given quantity of plutonium residue or scrub alloy.

External radiation from a package must be below specified limits that minimize the exposure of the handling personnel and general public. For these types of shipments, the external radiation dose rate during normal transportation conditions must be maintained below the following limits of 49 CFR Part 173 (DOT 1992a):

- 10 millirem per hour (mrem/hr) at any point 2 m (6.6 ft) from the vertical planes projected by the outer lateral surfaces of the transport vehicle (referred to as the regulatory limit throughout this document)

- 2 mrem/hr in any normally occupied position in the transport vehicle.

Plutonium residues and scrub alloy would be shipped from Rocky Flats to other sites for processing in Type B containers. The U.S. Department of Energy (DOE) uses several containers that meet the Type B specifications and which may be selected for these shipments. The 6M container has been used for transporting plutonium metal and is the packaging assumed in this EIS for shipment of those materials. Most likely, plutonium-bearing residues and scrub alloy would be shipped in containers such as the 9968, the 9975, and the 6M container. Other containers, such as TRUPACT, 9965 or 9972 through 9974 could be evaluated and used in place of the 6M, 9968, and 9975 containers. These containers are described in the following sections.

E.3.1.1 Type 6M Packaging

The original Department of Transportation 6M packaging (49 CFR 173.354) was Dow Chemical Corporation's Model 1518, a 38-liter (L) (10-gallon [gal]) container, approved by the U.S. Atomic Energy Commission (now DOE) in March 1967 and issued as U.S. Department of Transportation Special Permit 5000 the following month. The 6M packaging was issued in December 1968 to cover a variety of similar containers ranging in capacity from 38 to 417 L (10 to 110 gal). The 6M packaging is currently authorized by the Department of Transportation regulations for shipment of Type B quantities of radioactive materials (49 CFR 173, Subpart I).

In 1980, the U.S. Nuclear Regulatory Commission expressed concern about shipping plutonium in the 6M packaging. Because of changing specifications, secondary containment for plutonium was required (NRC 1998b). The U.S. Nuclear Regulatory Commission decided the 6M packaging was adequate as an overpack.

As secondary containment was required, the U.S. Nuclear Regulatory Commission also wanted assurance that the Department of Transportation Specification 2R (Inside Containment Vessel) would meet the new leak rates specified in the International Atomic Energy Agency regulations (Kelly 1994).

General construction requirements for the 6M packaging may be found in 49 CFR 178.354, "Specification 6M; Metal Packaging," and for the 2R vessel in 49 CFR 178.360. Refer to **Figure E–1** for an example of a typical 6M and the 2R inner vessel or container.

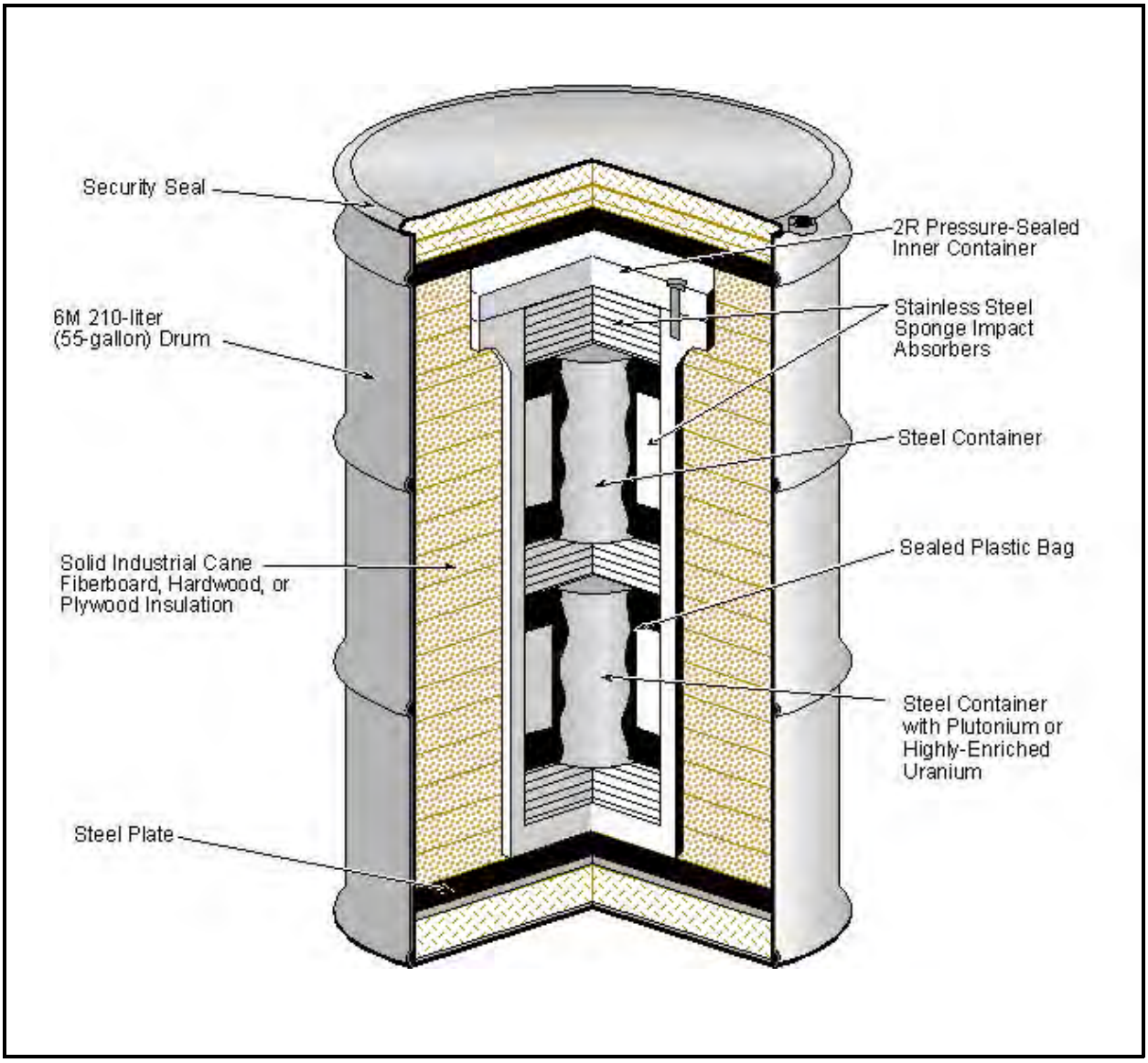

Figure E–1 Typical Assembly of 6M, Type B Packaging for Plutonium (Other than Pits)

In response to U.S. Nuclear Regulatory Commission concerns, the DOE and its contractors expended considerable effort to determine what role the 6M packaging should have for shipping DOE-owned plutonium. The three alternatives selected for evaluation were as follows:

- Improve the 6M procedures to resolve specific concerns raised by the U.S. Nuclear Regulatory Commission

- Procure and use packaging that is presently certified for shipment of plutonium

- Design and certify a new packaging to ship plutonium.

The first alternative was chosen. Technical reviews and safety assessments have been performed on 6M specification packaging, 2R inner container welds associated with 6M packaging, the types and quantities of radioactive material being shipped in 6M packaging, and future packaging to replace the 6M. In 1988, a DOE

task force performed a technical review of the 6M packaging configuration. The review and subsequent documentation found that the 6M packaging configuration merits continued use (SNL 1988).

The task force that studied this subject recognized that the use of the 6M is authorized by current U.S. Department of Transportation regulations and recommended procedural improvements for its continued use. It was determined that the number of product can configurations and the number of 6M drum sizes should be reduced, and that the major shipping sites should coordinate an effort to minimize the number of can configurations and drum sizes used for shipment of plutonium.

In 1988, weld defects were found in the DT-14A packages fabricated by a particular manufacturer. Because the manufacturer was a major supplier of 2R inner containers, the integrity of 2R inner containers became a concern. In 1989, DOE Headquarters issued directives (Wade 1989) to all Defense Programs Operations Offices that future shipments of Type B radioactive material in the 6M packaging implement the applicable requirements as specified in the DOE task force's technical document (SNL 1988). The Container Weld Advisory Committee was formed in 1989 to develop recommendations and provide criteria for specific weld issues related to the 2R inner container. The Container Weld Advisory Committee recommended static force testing to ensure that the weld was strong enough to withstand the postulated hypothetical accident condition loadings. The leak testing was to ensure no leak paths existed in the weld. The safety enhancements developed will allow interim use of the 6M until a replacement container is available. As a result, 2R inner-containment vessels have had their bottom plate welds static force tested and leak tested. Additional requirements for Type B plutonium oxide shipments were also imposed, including an evaluation of the payload configuration against hypothetical accident conditions, load testing of the existing inner vessel (2R) welds, and DOE approval of the configuration. The purpose of the added requirements is to allow interim use of the 6M configuration until a replacement container is available (Kelly 1994).

- **Drum—**The outer shell is made of straight-sided steel, with welded body seams, and in accordance with Department of Transportation Specification 6C or 17C, with each length to contain 3 wedged or rolled rolling hoops as prescribed for either of these specifications. A removable head has one or more corrugations in the cover near the periphery. For a packaging exceeding 57 L (15 gal) volume, the head must be crowned (convex), not extending beyond the level of the chime, with a minimum convexity of 1 cm (3/8 in).

  Each drum has at least four 1.2-cm (0.5-in) diameter vents near the top, each covered with a weatherproof tape or fusible plug, or equivalent device. A layer of porous refractory fiber may be placed behind the pressure-relief vent holes.

  The outer drum closure is at least a 16-gauge bolt-type locking ring having at least a 5/16-in steel bolt for drum sizes not over 15 gal or a 12-gauge bolted ring with drop-forged lugs, one of which is threaded, and a 5/8-in steel bolt for drum sizes over 15 gal. Each bolt is provided with a lock nut or equivalent device.

  The closure device has means for the attachment of a tamper-proof lock wire and seal.

- **Insulation—**The inner containment vessel is fixed within the outer shell by solid centering media, with the sides of the inner vessel protected by at least 9.5 cm (3.75 in) of insulation media, and the ends with at least the thickness as prescribed in 49 CFR 178.104-3(a)(1). The centering media is usually machined discs and rings made of solid industrial can fiberboard having a density of at least 0.24 grams per cubic centimeter (15 lb per cubic foot) fitted such that the radial clearances between the fiberboard, inner vessel, and shell do not exceed 6 millimeters (1/4-in).

- **Shielding—**When necessary, shielding may be provided within the 2R containment vessel. Any radiation shielding material used must be placed within the inner containment vessel or must be protected in all directions by at least the thickness of the thermal insulating material.

- **Primary Containment Vessel—**The primary containment vessel is constructed to Department of Transportation Specification 2R (49 CFR 178.360). Each vessel is made of stainless steel, malleable iron, or brass, or other material having equivalent physical strength and fire resistance.

  The closure device is a screw-type cap or plug. The number of threads per inch must not be less than U.S. standard pipe threads and must have sufficient length of thread to engage at lease five threads when securely tightened. Pipe threads are luted with an appropriate nonhardening compound which must be capable of withstanding up to 149°C (300°F) without loss of efficiency. Tightening torque is adequate to maintain leak tightness with the specific luting compound.

- **Product Cans—**The following cans are authorized for Rocky Flats shipments (SNL 1988):

Material to be Packaged	***Can Dimensions***	***Descriptions***
Plutonium/ Aluminum/ Americium Alloy Button	Can (outer), 11.9-cm diameter (dia), 25.07-cm tall (4.7-in dia, 9.87-in tall)	Ellisco #110345, aluminum, with D-ring handle.
	Can (inner), 11.11-cm dia, 11.89-cm tall (4.375-in dia, 4.68-in tall)	Ellisco #113044, aluminum.
Plutonium Metal	Can (outer), 10.8-cm dia, 17.8-cm tall (4.25-in dia, 7-in tall)	• Per Federal Specification PPP-C-96E, Type 1, Class 3, round, open-top style, welded side seam with compound-lined double-seamed ends. • 0.25 electrolytic tinplate for all cans. Body is 0.038-cm (0.015-in) thick, ends are 0.03-cm (0.812-in) thick, no end profile.
	Can (inner), 10.31-cm dia, 14.12-cm tall (4.06-in dia, 5.56-in tall)	• Per Federal Specification PPP-C-96E, Type 1, Class 3, round, open-top style, welded side seam with compound-lined double-seamed ends. • 0.25 electrolytic tinplate for all cans. Body is 0.038-cm (0.012-in) thick, any end profile authorized.
Plutonium Oxide	Can (outer), 10.8-cm dia, 17.8-cm tall (4.25-in dia, 7-in tall)	• Per Federal Specification PPP-C-96E, Type 1, Class 3, round, open-top style, welded side seam with compound-lined double-seamed ends. • 0.25 electrolytic tinplate for all cans. Body is 0.038-cm (0.015-in) thick, ends are 0.03-cm (0.012-in.) thick, no end profile.
	Can (middle) 10.31-cm dia, 14.12-cm tall (4.06-in dia, 5.56-in tall)	• Per Federal Specification PPP-C-96E, Type 1, Class 3, round, open-top style, welded side seam with compound-lined double-seamed ends. • 0.25 electrolytic tinplate for all cans. Body is 0.038-cm (0.012-in) thick, any end profile authorized.
	Can (inner), 8.74-cm dia, 11.58-cm tall (3.44-in dia, 4.56-in tall)[c]	• Per Federal Specification PPP-C-96E, Type 1, Class 3, round, open-top style, welded side seam with compound-lined double-seamed ends. • 0.25 electrolytic tinplate for all cans. Body and ends are 0.025-cm (0.010-in) thick, any end profile authorized.

Material to be Packaged	*Can Dimensions*	*Descriptions*
Plutonium/ Aluminum/ Americium Alloy Button, Anode Heels, and Category 3 Metal	Can (outer), 11.43-cm dia, 12.4-cm tall (4.5-in dia, 4.88-in tall)	• Special order. Welded side seam body. • Unsealed end, round, open-top style lid, compound lined with Parexd compound 313 (38.5-40.5) or Parex exp compound AD 23118 LS, double-seamed closure. • Sealed end, no compound allowed, double-seamed, sealed with lead-free tin solder; 0.25 electrolytic tinplate all surfaces of can body and lids. • 0.038-cm (0.015-in) thick body, 0.03-cm (0.012-in) thick ends, no end profile.

❒ **Impact Absorbers—**Silicone sponge impact absorbers, made of medium-grade closed-cell silicone sponge rubber, are used.

❒ **Contents of Package—**A list of the authorized contents of package, by Rocky Flats drawing number, follows:

Drawing Number	*Material to be Packaged*	*Maximum Material per 2R kg (lb)*	*Maximum Material per Inner Can kg (lb)*
33021-01	Plutonium/Aluminum/Americium Alloy Button	4.5 (9.92)	2.3 (5.07)
33021-02	Plutonium-Contaminated ^{235}Uranium	2.0 (4.41)	2.0 (4.41)
33021-03	Enriched Uranium or Plutonium Metal ^{238}Plutonium Metal	4.5 (9.92) 0.02 (0.04)	2.3 (5.07) 0.02 (0.04)
33021-04	Plutonium Oxide ^{238}Plutonium Oxide	4.5 (9.92) 0.02 (0.04)	2.3 (5.07) 0.02 (0.04)
33021-05	Plutonium Oxide ^{238}Plutonium Oxide	4.5 (9.92) 0.02 (0.04)	2.3 (5.07) 0.02 (0.04)
33020-09	Plutonium/Aluminum/Americium Alloy Button, Anode Heels, and Category 3 Metal	4.5 (9.92)	2.3 (5.07)

E.3.1.2 Type 9975 Packaging

The 9975 type packagings consist of stainless steel containment vessels enclosed within cane fiberboard insulation within a steel drum. The packagings have a double containment assembly of a primary containment vessel with a secondary containment vessel. The 9975 type packagings is the last of a series of Type B containers designed to overcome the drawbacks of the 6M container. The other Type B packagings are 9965, 9968, 9972, and 9974. The 9975 type packaging has a lead shielding insert between the secondary containment vessel and the insulation. The steel drum defines the confinement boundary, and the containment vessels define the containment boundary (WSRC 1996).

The 9975 package assembly is shown in **Figure E–2**. Lead shielding is provided in the 9975 packaging. The 9975 packaging weighs 163 kg (360 lb). The 13-cm (5-in) extension to the 30-gal drum results in a drum that is 89 cm (35-in) high with a 132-L (35-gal) capacity. The containment vessels and the drum are all made of Type 304L stainless steel. The bolts are high-strength alloy steel and the shielding is lead. Containers 9965, 9968, and 9972 through 9974 are similarly constructed, and are technically capable of transporting plutonium-bearing material. The following paragraphs describe specific aspects of the packagings.

- **Drum—**The drum is fabricated as a 132-L (35-gal) removable-head drum. The drum is fabricated of 18–gauge Type 304L stainless steel. Four vent holes are drilled into the drum, approximately 90 degrees apart, just below the top curl and are covered with a Caplug (fusible plug).

  The plugging device prevents water or moisture from entering the drum through the vent holes under normal conditions of transport. In the event a fire occurs, the plug melts, allowing the drum to vent gases generated from the insulation to prevent rupture of the drum. A locking ring with lugs, installed with a high-strength steel bolt, secures the cover to the drum. The steel bolt threads into the lug and must be provided with a jam nut to prevent loosening during transit. A small hole is drilled through both lugs for insertion of a wire seal to function as a tamperproof device.

- **Insulation—**The insulation material that surrounds the containment vessels is cane fiberboard and is manufactured per American Society for Testing and Materials Specification C-208-72. The cane fiberboard insulation comes in sheets that are bonded together into top and bottom subassemblies with a water-based carpenter's glue. The insulation subassemblies are fitted to the drum so that the radial clearances between the insulation, the lead cylinder, and the drum do not exceed 0.635 cm (1/4 in). Placed over and glued to the top fiberboard subassembly is an air shield made of stainless steel. This thin-walled shield prevents possible smoldering of the top fiberboard layers when exposed to air in a fire. A length of sash chain welded to the top of the air shield serves as a handle for removing the top subassembly.

  A filler pad is required between the top insulation subassembly and the drum lid. The filler pad consists of a ceramic fiber blanket (Kaowool) encapsulated in stainless steel foil and heat sealed.

- **Shielding—**The radiation shielding configuration is a lead cylinder assembly that surrounds the primary containment vessel/secondary containment vessel double-containment assembly. The shielding assembly consists of an inside cylinder fabricated of lead, surrounding a stainless steel tubing weldment. The lid is made of aluminum. The lid has four equally spaced bolt holes near the edge for attachment to the cylinder body. The shielding assembly has no lead lid since the thickness of the stainless steel lids for the primary and secondary containment vessels provide sufficient shielding.

- **Bearing Plates—**Two aluminum bearing plates are added to the packaging to provide additional load-bearing surfaces against the cane fiberboard insulation.

- **Primary Containment Vessel—**The primary containment vessel is of a stainless steel pressure vessel designed in accordance with Section III of the *American Society of Mechanical Engineers Boiler and Pressure Vessel Code*, 1992 edition, with design conditions of 10.3 bar (150 lb per square in gauge [psig]) at 260°C (500°F) for normal conditions of transport and 20.6 bar (300 psig) at 260°C (500°F) for hypothetical accident conditions. By definition, the design conditions shall be higher than the pressures and temperatures that can be generated under normal or accident conditions of transport.

  The primary containment vessel is fabricated from 12.7-cm (5-in) Schedule 40, seamless, Type 304L stainless steel pipe and has a standard Schedule Type 304L stainless steel pipe cap at the blind end. Both vessel body joints are circumferential full penetration butt welds examined by radiographic and liquid

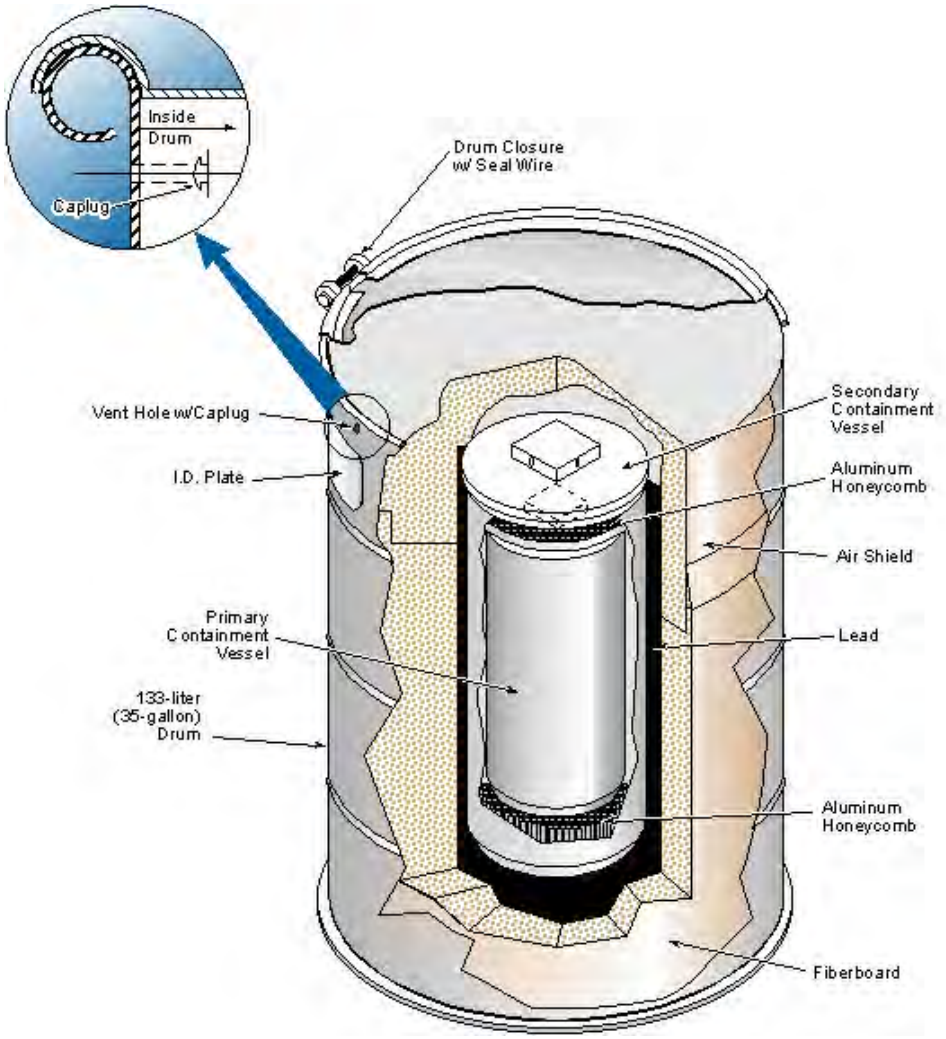

Figure E–2 Typical Assembly of Type 9975 Package

penetrant methods. These welds satisfy *American Society of Mechanical Engineers Boiler and Pressure Vessel Code*, Section III, Subsection NB, requirements.

A 10-cm (4-in), Schedule 40 pipe of the same material is welded to the convex side of the cap to form a skirt to vertically support the primary containment vessel. The skirt has two slots on the bottom surface (180 degrees apart) to engage a rectangular key to prevent vessel rotation.

The primary containment vessel closure is male-female cone joint with surfaces that have been machined to identical angles so that they mate with zero clearance. Two grooves for O-rings have been machined onto the face of the Type 304L stainless steel male cone. A leak test port is provided between the two O-ring grooves. A small rectangular groove is present on the face of the male cone between the two O-ring grooves. This is to ensure helium detection during leakage testing. Two Viton GLT fluoroelastomer O-rings (greased with high vacuum silicone grease) are placed in the grooves to form a leaktight seal. Zero

clearance behind the two O-rings prevents extrusion and loss of sealing ability at design pressures and temperatures. The leak test port allows for simple leakage tests (pressure drop method) when opening a loaded containment vessel. When the leak test port is plugged (as in normal shipment), a redundant O-ring seal is formed. A snap-ring fits onto the male cone for use in unseating the cone during disassembly. The seal nut, which forces the male cone against the female cone, is threaded into the containment vessel body. Dissimilar materials were selected for the seal nut (Nitronic 60) and the containment vessel body (Type 304L stainless steel) to minimize galling.

- **Honeycomb Spacer—**An aluminum honeycomb spacer is inserted into the concave cavity of the primary containment vessel to provide a flat horizontal surface for the product cans.

- **Product Cans—**The uranium and plutonium metal and oxides are normally placed inside metal cans prior to removing the items from the glove box. Metal cans with organic food liners cannot be used. A rubber gasket material may be applied to the edge of the lid to ensure an hermetic is achieved. The lid is then mechanically crimped to the can wall. The cans are made from either tin-plated mild steel or aluminum.

  The can containing the radioactive material is then placed in a low-density polyethylene bag. The low-density polyethylene bag must meet American Society for Testing and Materials Specification D-4635. Sometimes a second or even a third can is used. More than one bag can also be used. The use of polyvinyl chloride tape is allowed to seal slip-lid cans. However, the package content is limited to 100 grams of polyethylene. No credit for containment is taken for the can assembly.

- **Secondary Containment Vessel—**The secondary containment vessel shown in Figure E–2 consists of a stainless steel pressure vessel that is designed in accordance with Section III of the *American Society of Mechanical Engineers Boiler and Pressure Vessel Code*, 1992 edition. The secondary containment vessel is fabricated from 15.2-cm (6-in) Schedule 40, seamless, Type 304L stainless steel pipe and has a standard Schedule Type 304L stainless steel pipe cap at the blind end. Both vessel body joints are circumferential full penetration butt welds examined by radiographic and liquid penetrant methods. These welds satisfy *American Society of Mechanical Engineers Boiler and Pressure Vessel Code* Section III, Subsection NB requirements.

  A 12.7-cm (5-in), Schedule 40 pipe of the same material is welded to the convex side of the cap to form a skirt to vertically support the secondary containment vessel. Like the primary containment vessel, the secondary containment vessel skirt has two slots on the bottom surface (180 degrees apart) to engage a rectangular key to prevent vessel rotation. The secondary containment vessel closure is identical to that used on the primary containment vessel except that the secondary containment vessel is 2.5 cm (1 in) larger in diameter.

- **Impact Absorbers—**Aluminum honeycomb impact absorbers fit axially between the primary containment vessel and the secondary containment vessel. The top impact absorber has the shape of a ring. The bottom impact absorber is machined on the bottom face to fit the contour of the inside of the secondary containment vessel.

- **Operational Features—**The primary containment vessel and secondary containment vessel may be loaded by placing them in a support stand. A lifting tool, which attaches to the seal nut on the primary containment vessel or secondary containment vessel, may be used to lift the assembled containment vessel, by the cone seal nut, from the drum overpack.

  A vacuum lifting tool may be used for raising and lowering product cans into the primary containment vessel. A socket extension may be used with a commercial torque wrench to tighten the closure.

After the radioactive material is inserted and the containment vessel closure tightened to the prescribed torque, the containment closure is leak tested. The plug at the top of the leak test port is removed, the cavity between the two O-rings in the cone seal is pressurized, and any loss of pressure is recorded.

- **Contents of Packaging—**Type B radioactive material, in addition to fissile materials, may be shipped in these packagings. The requirement of 10 CFR 71.63, *Special Requirements for Plutonium Shipments*, states that solid plutonium in excess of 20 Ci must be provided with double containment for shipment, with the exception of reactor fuel elements, metal or metal alloy, or other plutonium solids that U.S. Nuclear Regulatory Commission determines should be exempt. Because the 9975 packagings provide double containment, they are also authorized for products of oxide, scrap, or powders in amounts that exceed 20 Ci.

  The radioactive material contents of the 9975 packages must be limited to meet the criticality and shielding requirements of 10 CFR Part 71. In addition, a maximum allowable decay heat load of 19 watts is established to ensure that the packages meet performance requirements.

- **Thermal Design—**These packagings have been designed to ensure that all safety-related internal components operate below regulatory thermal limits. The components of interest include the lead shield (shielding) and the primary containment vessel, secondary containment vessel, and vessel seals (containment). The thermal limits and design pressures of these components are presented in the *Safety Analysis Report—Packages 9965, 9968, 9972–75* (WSRC 1996).

  The thermal design features of the 9975 packagings include an air shield and a thermal blanket. The air shield, located at the drum top, is designed to minimize the potential for the fiberboard insulation to burn in a fire. Placement of a stainless steel cover on the upper portion of the fiberboard leaves an air gap between the cover and drum wall. The cover prevents fiberboard burning during a post-fire cooldown by prohibiting air flow into the fiberboard near the vent holes. The blanket is used as a filler material between the drum top and lid and is noncombustible. The fiberboard insulation consists of two main sections, each formed by stacking layers of fiberboard and gluing them together (from bottom to top). The sections are "stepped" to eliminate the possibility of a direct thermal shine path (i.e., radiant heat transfer path) from the drum wall to the lead shielding or the vessel wall after the 9.1-m (30-ft) free-drop test.

  The packagings employ a passive cooling and insulation system. Radioactive decay heat from the contents is radiated and conducted to the inner and outer product cans and to the walls of the primary containment vessel. In packagings with a double containment assembly, the heat is primarily transported radially by radiation and conduction across an air gap to the secondary containment vessel and across another air gap directly to the lead shield. The decay heat is primarily conducted radially through the insulation to the outer 132-L (35-gal) drum where it is radiated and convected to the ambient.

E.3.1.3 DOE Standard 3013 Storage and Transportation Container

Plutonium oxide produced from salt distillation, acid dissolution or water leach at Los Alamos National Laboratory will be loaded into packaging that meets the DOE-STD-3013-96, *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE 1996b) or equivalent. This package provides for safe storage of plutonium oxides for at least 50 years or until final disposition, and, serves as the primary containment vessel for shipping. DOE-STD-3013-96 specifies a design goal that the package could be shipped in qualified shipping containers without further reprocessing or repackaging.

The 3013 primary containment vessel is designed for shipping, and would be compatible with a Type-B package, similar to the previously. No Type-B package has been specifically constructed or licensed for shipping DOE-STD-3013-96 primary containment vessels.

E.3.2 Shipment Overview

E.3.2.1 Safe Secure Transportation

Currently the Department anticipates that any transportation of the scrub alloy and those plutonium residues with the highest plutonium concentrations would definitely be required to be made through use of the Transportation Safeguards System and shipped using the Safe Secure Trailer System. Nevertheless, the Department is evaluating whether it would be possible to use commercial carriers for shipments of plutonium residues containing low concentrations of plutonium, and whether there would be any advantage to such shipments. The Safe Secure Trailer is a fundamental component of the Transportation Safeguards System. The Transportation Safeguards System is operated by the DOE Transportation Safeguards Division of the Albuquerque Operations Office for the DOE Headquarters Office of Defense Programs. Based on operational experience between FY84 and FY93, the mean probability of an accident requiring the tow-away of the safe secure trailer was 0.11 accidents per million km (0.066 accidents per million mi). By contrast, the rate for commercial trucking in 1989 was about 4.3 accidents per million km (2.7 accidents per million mi). Commercial trucking accident rates (Saricks and Kvitek 1994) were used in the human health effects analysis. Since established in 1975, the Transportation Safeguards Division has accumulated more than 145 million km (90 million mi) of over-the-road experience transporting DOE-owned cargo with no accidents resulting in a fatality or release of radioactive material.

The safe secure trailer is a specially designed component of an 18-wheel tractor-trailer vehicle. Although details of vehicle enhancements and some operational aspects are classified, key characteristics of the safe secure trailer system include the following:

- Enhanced structural characteristics and a highly reliable tie-down system to protect cargo from impact
- Heightened thermal resistance to protect the cargo in case of fire
- Various deterrents to prevent unauthorized removal of cargo
- An armored tractor component that provides courier protection against attack and contains advanced communications equipment
- Specially designed escort vehicles containing advanced communications and additional couriers
- 24-hour-a-day real-time communications to monitor the location and status of all safe, secure trailer shipments via DOE's Security Communication system
- Couriers who are armed Federal Officers and receive rigorous specialized training and who are closely monitored through DOE's Personnel Assurance Program
- Significantly more stringent maintenance standards than those for commercial transport equipment
- Conduct of periodic appraisals of the Transportation Safeguards System operations by Defense Programs to ensure compliance with DOE orders and management directives.,

E.3.3 Ground Transportation Route Selection Process

According to DOE guidelines, plutonium shipments must comply with both U.S. Nuclear Regulatory Commission and U.S. Department of Transportation regulatory requirements. Commercial shipments are required by law to comply with both U.S. Nuclear Regulatory Commission and U.S. Department of Transportation requirements. U.S. Nuclear Regulatory Commission regulations cover the packaging and transport of plutonium, whereas the U.S. Department of Transportation specifically regulates the carriers and the conditions of transport, such as routing, handling and storage, and vehicle and driver requirements. The highway routing of nuclear material is systematically determined according to U.S. Department of Transportation regulations 49 CFR 171-179 and 49 CFR 397 for commercial shipments. Specific routes cannot be publicly identified in advance for Transportation Safeguards Division shipments because they are classified to protect national security interests.

The U.S. Department of Transportation routing regulations require that shipment of a "highway route controlled quantity" of radioactive material be transported over a preferred highway network including interstate highways, with preference toward interstate system bypasses and beltways around cities, and State-designated preferred routes. A State or Tribe may designate a preferred route to replace or supplement the interstate highway system in accordance with U.S. Department of Transportation guidelines (DOT 1992b).

Carriers of highway route controlled quantities are required to use the preferred network unless moving from origin to the nearest interstate or from the interstate to the destination, when making necessary repair or rest stops, or when emergency conditions render the interstate unsafe or impassible. The primary criterion for selecting the preferred route for a shipment is travel time. Preferred routing takes into consideration accident rate, transit time population density, activities, time of day, and day of week.

The HIGHWAY computer code (Johnson et al. 1993) may be used for selecting highway routes in the United States. The HIGHWAY database is a computerized road atlas that currently describes about 386,400 km (240,000 mi) of roads. The Interstate System and all U.S. (US-designated) highways are completely described in the database. In addition, most of the principal State highways and many local and community roads are also identified. The code is updated periodically to reflect current road conditions and has been benchmarked against reported mileages and observations of commercial truck firms. Features in the HIGHWAY code allow the user to select routes that conform to the Department of Transportation regulations. Additionally, the HIGHWAY code contains data on the population densities along the routes. The distances and populations from the HIGHWAY code are part of the information used for the transportation impact analysis in this EIS.

E.4 METHODS FOR CALCULATING TRANSPORTATION RISKS

The overland transportation risk assessment methodology are summarized in **Figure E–3**. After the EIS alternatives are identified and goals of the shipping campaign are understood, the first step is to collect data on material characteristics and accident parameters. Physical, radiological and packaging data were provided by the DOE sites. Accident parameters are largely based on the DOE-funded study of transportation accidents (Saricks and Kvitek 1994).

Representative routes that may be used for the shipment of plutonium residues and scrub alloy have been selected using the HIGHWAY code. These routes were selected for risk assessment purposes. They do not necessarily represent the actual routes that would be used to transport nuclear materials. Specific routes cannot be identified in advance because the routes would not be finalized until they had been reviewed and approved by U.S. Nuclear Regulatory Commission. The selection of the actual route would be responsive to environmental and other conditions that would be in effect or could be predicted at the time of shipment. Such

conditions could include adverse weather conditions, road conditions, bridge closures, and local traffic problems. For security reasons, details about a route would not be publicized before the shipment.

The first analytic step in the ground transportation analysis was to determine the incident-free and accident risk factors, on a per-shipment basis, for transportation. Risk factors, as any risk estimate, are the product of the probability of exposure and the magnitude of the exposure. Accident risk factors were calculated for radiological and nonradiological traffic accidents. The probabilities, which are much lower than one, and the

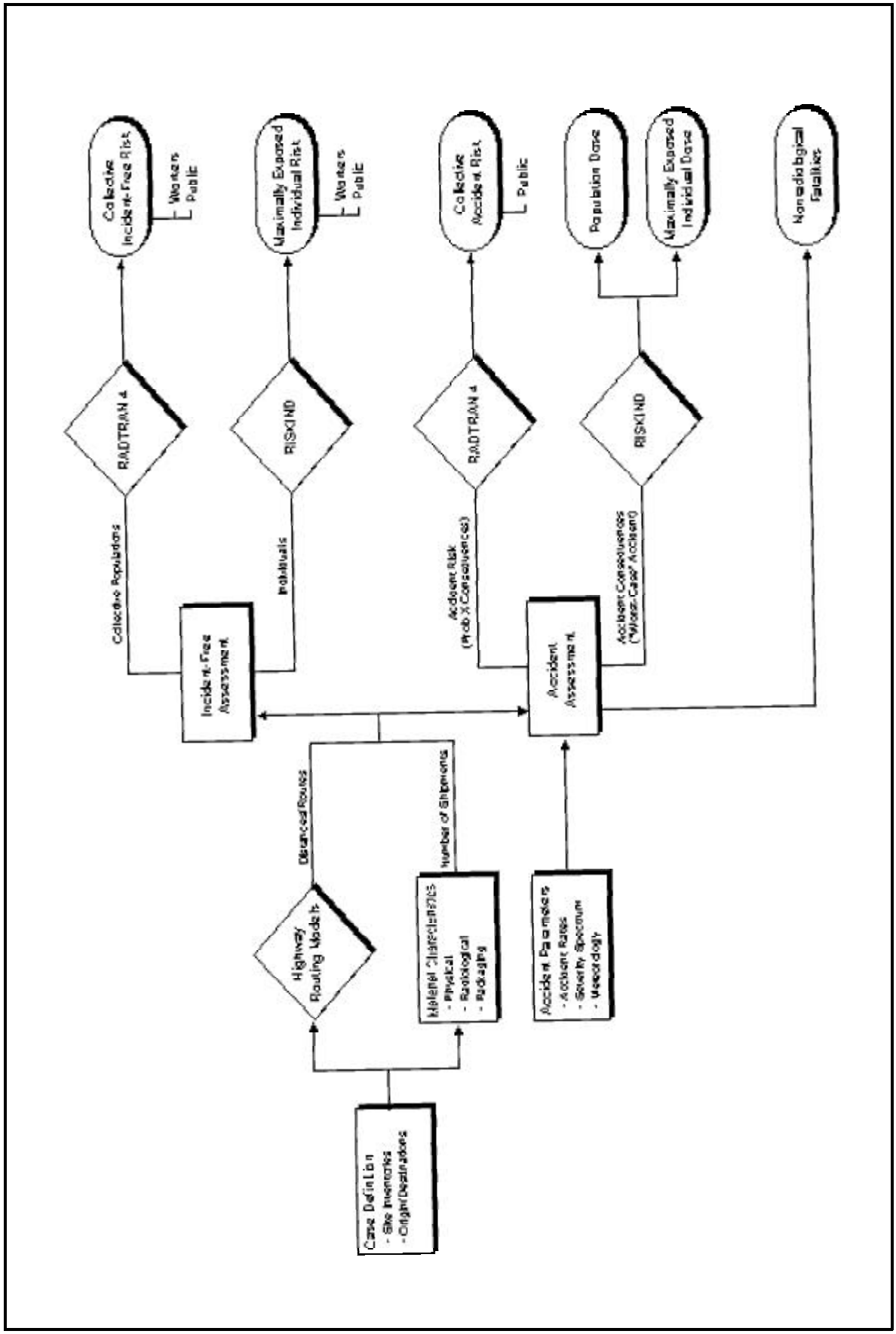

Figure E–3 Overland Transportation Risk Assessment

magnitudes of exposure were multiplied, yielding very low risk numbers. Incident-free risk factors were calculated for crew and public exposure to radiation emanating from the shipping container (cask) and public exposure to the chemical toxicity of the transportation vehicle exhaust. The probability of incident-free exposure is unity (one).

Radiological risk factors are expressed in units of rem. Later in the analysis, they will be multiplied by *International Commission on Radiation Protection Publication 60* (ICRP 1991) conversion factors and estimated number of shipments to give risk estimates in units of latent cancer fatalities. The vehicle emission risk factors are calculated in latent mortalities, and the vehicle accident risk factors are calculated in mortalities. The nonradiological risk factors will be multiplied by the number of shipments.

For each alternative, risks were assessed for both incident-free transportation and accident conditions. For the incident-free assessment, risks were calculated for both collective populations of potentially exposed individuals and for maximally exposed individuals. The accident assessment consists of two components: (1) a probabilistic accident risk assessment that considers the probabilities and consequences of a range of possible transportation accident environments, including low-probability accidents that have high consequences and high-probability accidents that have low consequences, and (2) an accident consequence assessment that considers only the consequences of the most severe transportation accidents postulated.

The RADTRAN 4 computer code (Neuhauser and Kanipe 1993) is used for incident-free and accident risk assessments to estimate the impacts on collective populations. RADTRAN 4 was developed by Sandia National Laboratories to calculate population risks associated with the transportation of radioactive materials by a variety of modes, including truck, rail, air, ship, and barge.

The RADTRAN 4 population risk calculations take into account both the consequences and probabilities of potential exposure events. The collective population risk is a measure of the total radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk is used as the primary means of comparing the various alternatives.

The RISKIND computer code (Yuan et al. 1995) is used to estimate the incident-free doses to maximally exposed individuals and for estimating impacts for the accident consequence assessment. The RISKIND computer code was developed for DOE's Office of Civilian Radioactive Waste Management to analyze the exposure of individuals during incident-free transportation. In addition, the RISKIND code was designed to allow a detailed assessment of the consequences to individuals and population subgroups from severe transportation accidents under various environmental settings.

The RISKIND calculations were conducted to supplement the collective risk results calculated with RADTRAN 4. Whereas the collective risk results provide a measure of the overall risks of each alternative, the RISKIND calculations are meant to address areas of specific concern to individuals and population subgroups. Essentially, the RISKIND analyses are meant to address "What if" questions, such as "What if I live next to a site access road?" or "What if an accident happens near my town?"

The DOE-developed Analysis of Dispersal Risk Occurring in Transportation was developed to provide probabilistic risk analysis of nuclear explosives, nuclear explosive components and other special nuclear material shipped in a safe, secure trailer (Clauss 1995).

Analysis of Dispersal Risk Occurring in Transportation is actually an integrated software tool for transportation risk assessment including:

- Analysis of Dispersal Risk Occurring in Transportation Analysis of Dispersal Risk Occurring in Transportation Analysis of Dispersal Risk Occurring in Transportation
- MELTER
- Explosive Release – Atmospheric Dispersal
- Latin Hypercube Sampling

These codes utilize an extensive set of data files including:

- Transportation Safeguards Division incident data
- commercial tractor semi-trailer accident data
- route data files
- meteorological data
- population data

Using these codes and data, an analysis that is specific to the material, packaging system, and route can be conducted. The most notable feature of Analysis of Dispersal Risk Occurring in Transportation is the event tree logic. The 17-question event tree describes scenarios by defining accident conditions, evaluating consequences and estimating unique sets of consequences for each end-state.

For this EIS, Analysis of Dispersal Risk Occurring in Transportation was used to analyze the shipment of scrub alloy in a 6M/2R package. This analysis provides a more realistic accident risk estimate for material shipped in a safe, secure trailer. A complete analysis of the 9975 container could be done with Analysis of Dispersal Risk Occurring in Transportation, but the thermal models for the 9975 container have not been created. Analysis of Dispersal Risk Occurring in Transportation is normally used for weapons components, and the 9975 container is not used for weapons components, so the input data and models have not been created.

E.5 PARAMETERS AND ASSUMPTIONS

The transportation risk assessment is designed to ensure—through uniform and judicious selection of models, data and assumptions—that relative comparisons of risk among the various alternatives are meaningful. The major input parameters and assumptions used in the transportation risk assessment are discussed below.

E.5.1 Material Inventory

For the purposes of analysis, the plutonium residues and scrub alloy have been characterized into the different materials show in **Table E–1**. Note that several materials will not be shipped and were not considered further in the transportation analyses. All materials would be shipped from Rocky Flats to the Savannah River Site, except the possible shipment of pyrochemical salt residues. These pyrochemical salt residues could be shipped to the Los Alamos National Laboratory site, as noted in Table E–1.

E.5.2 Shipment External Dose Rates

The dose and corresponding risk to populations and maximally exposed individuals during incident-free transportation conditions are directly proportional to the assumed shipment external dose rate. The Federal regulations for maximum allowable dose rates for exclusive-use shipments were presented in Section E.3.1.

The actual shipment dose rate is a complex function of the composition and configuration of shielding and containment used in the cask, the geometry of the loaded shipments, and characteristics of the material shipped. Rocky Flats has years of experience handling the materials listed in Table E–1 and has regularly made radiation

level measurements while handling these materials. The maximum predicted dose, based on experience at DOE facilities, from individual packages, would yield a dose rate less than the Federal regulatory limit in every case. However, in order to ensure a conservative analysis, a dose rate equal to the regulatory limit was used in all risk analyses.

Table E–1 Summary of Material Shipping Requirements

Material	*Safe Secure Trailer Required* [a]	*Container*	*Number of Shipments*	*kg Pu per Shipment*	*Total Pu (kg)*
Shipments from Rocky Flats:					
Ash Residues					
Incinerator Ash and Firebrick Fines					
Purex	No	9975	116	8	900
MEO/Purex	No	9975	86	10	890
Pulverized Sand, Slag, and Crucibles	No	9975	26	5	129
Graphite Fines for MEO	No	9975	7	11	74
Inorganic Ash	Not Shipped				
Salt Residues					
Electrorefining & Molten Salt Extraction					
Salt Distillation at LANL - IDC 409	No	9975	6	39	235
Salt Distillation at LANL - All other IDCs	No	9975	44	13	569
Purex at SRS (following Scrub) - IDC 409	No	9975	7	33	228
Purex at SRS (following (Scrub) - All other IDCs	No	9975	15	37	553
Direct Oxide Reduction Salts					
Acid Dissolution or Water Leach at LANL - IDCs 365, 413, 417, & 427	No	9975	3	46	138
Acid Dissolution or Water Leach at LANL - All other IDCs	No	9975	10	5	51
Purex at SRS (following Scrub) - IDCs 365, 413, 417, & 427	No	9975	3	45	134
Purex at SRS (following Scrub) - All other IDCs	No	9975	1	49	49
Combustible Residues	Not shipped				
Plutonium Fluoride Residues	Yes	9975	7	20	141
Filter Media Residues	Not shipped				
Sludge Residues	Not shipped				
Glass Residues	Not shipped				
Graphite Residues (MEO)	No	9975	16	6	96
Inorganic (Metals and Others)	No	9975	4	19	18
Existing Scrub Alloy	Yes	6M	6	33	200

kg = kilogram Pu = plutonium MEO = mediated electrochemical oxidation LANL = Los Alamos National Laboratory SRS = Savannah River Site

[a] Interpreted from DOE Order 5633.3B, "Control and Accountability of Nuclear Materials." However, DOE currently expects to use the Safe, Secure Trailer for added assurance.

E.5.3 Material Characterization Data

For the purpose of analysis, the isotopic mixtures for aged weapons grade plutonium and high americium salt were used (see Table D–28). The weapons grade plutonium contains five different plutonium isotopes, as well as a measurable quantity of americium, which is produced as plutonium decays. As the plutonium ages, the mixture changes.

E.5.4 Representative Routes and Population

Representative overland truck routes have been selected for the shipments to the Savannah River Site and to the Los Alamos National Laboratory. The routes were selected consistent with current routing practices and all applicable routing regulations and guidelines. However, the routes were determined for risk assessment purposes. They do not necessarily represent the actual routes that would be used to transport plutonium residues and scrub alloy in the future. Specific routes cannot be identified in advance. The representative routes are shown in **Figure E–4**.

Route characteristics that are important to the radiological risk assessment include the total shipment distance and the population distribution along the route. The specific route selected determines both the total potentially exposed population and the expected frequency of transportation-related accidents. Route characteristics are summarized in **Table E–2**. The exposed population includes all persons living within 800 m (0.5 mi) of each side of the road.

Table E–2 Summary of Route Distances and Population Distributions [a]

Parameter	*Rocky Flats to the Savannah River Site*	*Rocky Flats to Los Alamos National Laboratory*
Distance	2,616.7 km (1,625.0 mi)	733.8 km (456.0 mi)
Percentages in Zones		
Rural	78.2	83.5
Suburban	19.3	13.4
Urban	2.5	3.1
Average Persons per km^2 (mi^2)		
Rural	8.9/km^2 (23.1/mi^2)	4.5/km^2 (11.7/mi^2)
Suburban	358.4/km^2 (931.8/mi^2)	451.5/km^2 (1,169.4/mi^2)
Urban	2,239.7/km^2 (5,823.2/mi^2)	2,260.6/km^2 (5,854.91/mi^2)
Number of Affected Persons [b]	553,000	158,000

[a] Route characteristics were generated using the routing model HIGHWAY (Johnson et al. 1993).
[b] The affected population includes all persons within 800 m (0.5 mi) of the route.

E.5.5 Health Risk Conversion Factors

The health risk conversion factors used to estimate expected cancer fatalities were taken from *International Commission on Radiation Protection Publication 60* (ICRP 1991): 0.0005 and 0.0004 fatal cancer cases per person-rem for members of the public and workers, respectively. Cancer fatalities and incidence occur during the lifetimes of the exposed populations and, thus, are called latent cancer fatalities.

E.5.6 Accident Involvement Rates

For the calculation of accident risks, vehicle accident and fatality rates are taken from data provided in other reports (Saricks and Kvitek 1994). Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with accident-involvement count as the numerator of the fraction and vehicular activity (total travel distance) as its denominator. Accident rates are generally determined for a multi-year period. For

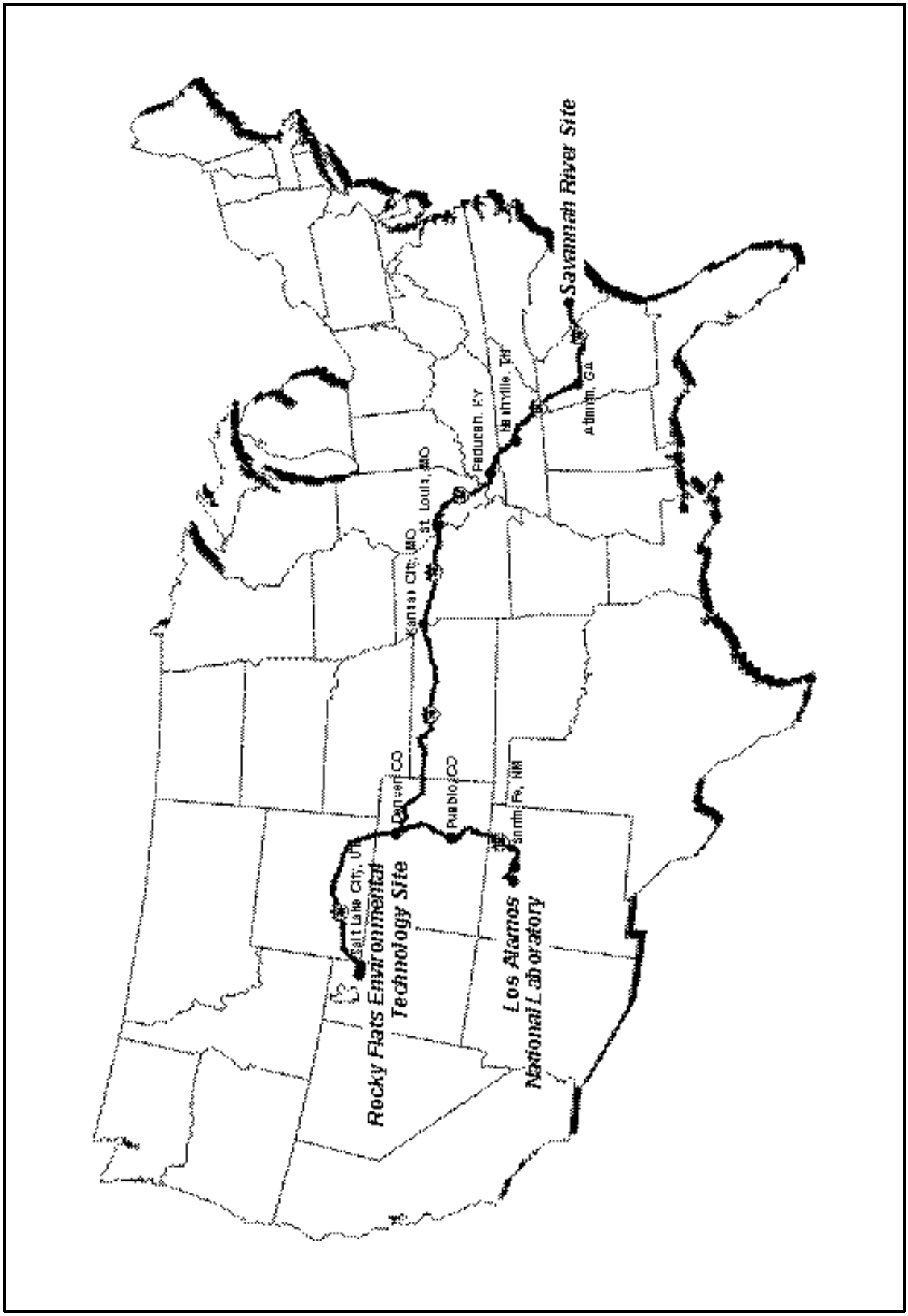

Figure E–4 Representative Routes

assessment purposes, the total number of expected accidents or fatalities is calculated by multiplying the total shipment distance for a specific case by the appropriate accident or fatality rate. For truck transportation, the rates presented are specifically for heavy combination trucks involved in interstate commerce (Saricks and Kvitek 1994). Heavy combination trucks are rigs composed of a separable tractor unit containing the engine and one to three freight trailers connected to each other. Heavy combination trucks are typically used for radioactive waste shipments. The truck accident rates are computed for each State based on statistics compiled by the Department of Transportation Office of Motor Carriers for 1986 to 1988. Saricks and Kvitek present accident involvement and fatality counts; estimated kilometers of travel by State; and the corresponding average accident involvement, fatality, and injury rates for the 3 years investigated. Fatalities are deaths (including crew members) attributable to the accident or that occurred at any time within 30 days thereafter.

E.5.7 Container Accident Response Characteristics and Release Fractions

The transportation accident model assigns accident probabilities to a set of accident categories. Eight accident-severity categories defined in the U.S. Nuclear Regulatory Commission's *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes*, NUREG-0170 (NRC 1977), were used. The least severe categories (Category I and II) represent low magnitudes of crush force, accident-impact velocity, fire duration, and/or puncture-impact speed. The most severe category (Category VIII) represents a large crush force, high accident-impact velocity, long fire duration, and a high puncture-impact speed. The fraction of material released and material aerosolized, and the fraction of that material that is respirable (particles smaller than 10 microns) was assigned based on the accident categories. Since all shipments will use the previously described Type B containers and the Safe Secure Trailer System, even severe accidents release, at the most, a portion of the material being transported.

E.6 RISK RESULTS

In this section, the risk assessment results are presented for the shipment materials and destinations being considered. The collective population risk results are presented in Section E.6.1, and the results are consolidated in Section E.6.2 so the different alternatives can be analyzed. Section E.6.3 describes the doses to the maximally exposed individuals.

E.6.1 Per-Shipment Risk Factors

Per-shipment risk factors have been calculated for the collective populations of exposed persons and for the crew for all anticipated routes and shipment configurations. The radiological risks are presented in doses per shipment for each unique route, material, and container combination. The radiological dose per shipment factors for incident-free transportation are presented in **Table E–3**. Doses are calculated for the crew, off-link public (i.e., people living along the route), on-link public (i.e., pedestrians and drivers along the route), and public at rest and fueling stops (i.e., stopped cars, buses and trucks, workers, and other bystanders). The radiological dose risk factors for accident transportation conditions are presented in **Table E–4**. The accident risk factors are called "dose risk" because the values incorporate the spectrum of accident severity probabilities and associated consequences.

The nonradiological risk factors are presented in fatalities per shipment in **Table E–5**. Separate risk factors are provided for fatalities resulting from hydrocarbon emissions (known to contain carcinogens) and transportation accidents (fatalities resulting from impact).

Table E–3 Incident-Free Radiological Doses per Shipment for All Material Types (Person-rem/Shipment) [a]

Origin	*Destination*	*Crew*	*Public*			
			Off-Link	*On-Link*	*Stops*	*Total*
Rocky Flats	Savannah River Site	0.155	0.00146	0.0112	0.0860	0.0987
Rocky Flats	Los Alamos National Laboratory	0.0415	0.000365	0.00293	0.0241	0.0274

[a] Incident-free risk factors are based on dose rates of 10 mrem per hour at 2 m from the vehicle.

Table E–4 Accident Radiological Dose Risk per Shipment for Each Material Type (Person-rem/Shipment)

Material	*Shipments from Rocky Flats to:*	
	Savannah River Site	*Los Alamos National Laboratory*
Ash Residues		
Incinerator Ash and Firebrick Fines		
Purex	0.000034	N/A
Mediated Electrochemical Oxidation/Purex	0.000046	N/A
Pulverized Sand, Slag, and Crucibles	0.000022	N/A
Graphite Fines for Mediated Electrochemical Oxidation	0.000047	N/A
Salt Residues		
Electrorefining & Molten Salt Extraction - IDC 409	0.000014	0.000029
Electrorefining & Molten Salt Extraction - All other IDCs	0.000016	0.000009
Direct Oxide Reduction Salts - IDCs 365, 413 & 427	0.000019	0.000033
Direct Oxide Reduction Salts - All other IDCs	0.000021	0.00004
Fluoride Residues	0.0009	N/A
Graphite Residues	0.000027	N/A
Inorganic Residues	0.000020	N/A
Scrub Alloy	0.000014	N/A

N/A = not applicable

Table E–5 Vehicle-Related (Nonradiological) Risk Factors per One-Way Shipment (Fatalities/Shipment)

Risk Factor	*Shipments from Rocky Flats to:*	
	Savannah River Site	*Los Alamos National Laboratory*
Vehicle Emissions	6.5×10^{-6}	2.3×10^{-6}
Vehicle Accident	0.000051	1.4×10^{-5}

E.6.2 Evaluation of Shipment Risks

Table E–6 shows the risks of transporting each of the plutonium residue and scrub alloy materials. The risks are calculated by multiplying the previously given per-shipment factors by the number of shipments and, in the case of the radiological doses, by the health risk conversion factors. Based on the results of the transportation risk analysis, it is unlikely that shipping plutonium residues and scrub alloy will result in a fatality.

Table E–6 Overland Transportation Risks for All Materials [a]

Material	Routine			Accidental	
	Radiological		Nonradiological [b]		Radiological
	Crew	Public	Emissions	Traffic	
Ash Residues (to Savannah River Site)					
Incinerator Ash & Firebrick Fines					
Purex	0.0072	0.0057	0.00152	0.01181	2.0×10^{-6}
Mediated Electrochemical Oxidation/Purex	0.0053	0.0042	0.00113	0.00875	2.0×10^{-6}
Pulverized Sand, Slag & Crucibles	0.0016	0.0013	0.00034	0.00265	2.8×10^{-7}
Graphite Fines for Mediated Electrochemical Oxidation	0.0004	0.0003	0.00009	0.00071	1.6×10^{-7}
Salt Residues					
Electrofining & Molten Salt Extraction					
Salt Distillation at LANL - IDC 409	0.0001	0.0001	0.00003	0.00017	8.6×10^{-8}
Salt Distillation at LANL - All other IDCs	0.0007	0.0006	0.00020	0.00125	2.1×10^{-7}
Purex at SRS (following Scrub) - IDC 409	0.0004	0.0003	0.00009	0.00071	4.9×10^{-8}
Purex at SRS (following Scrub) - All other IDCs	0.0009	0.0007	0.00020	0.00153	1.2×10^{-7}
Direct Oxide Reduction Salts					
Acid Dissolution or Water Leach at LANL - IDCs 365, 413 & 427	0.00005	0.00004	0.00001	0.00009	5.0×10^{-8}
Acid Dissolution or Water Leach at LANL - All other IDCs	0.00017	0.00014	0.00005	0.00028	1.9×10^{-8}
Purex at SRS (following Scrub) - IDCs 365, 413, & 427	0.00019	0.00015	0.00004	0.00031	2.9×10^{-8}
Purex at SRS (following Scrub) - All other IDCs	0.00006	0.00005	0.00001	0.00010	1.1×10^{-8}
Fluoride Residues (to Savannah River Site)	0.0004	0.0003	0.00009	0.00071	3.1×10^{-6}
Graphite Residues (to Savannah River Site)	0.0010	0.0008	0.00021	0.00163	2.1×10^{-7}
Inorganic Residues (to Savannah River Site)	0.0002	0.0002	0.00005	0.00041	4.0×10^{-8}
Existing Scrub Alloy (to Savannah River Site)	0.0004	0.0003	0.00008	0.00061	4.3×10^{-8}

LANL = Los Alamos National Laboratory SRS = Savannah River Site

[a] All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which represents a number of fatalities.

[b] These risks are associated with round-trip shipments.

E.6.3 Maximally Exposed Individuals

The risks to maximally exposed individuals under incident-free transportation conditions have been estimated for hypothetical exposure scenarios. The estimated dose to inspectors and the public is presented in **Table E–7** on a per-event basis (person-rem per event). Note that the potential exists for individual exposures if multiple exposure events occur. For instance, the dose to a person stuck in traffic next to a shipment for 30 minutes is calculated to be 11 mrem. If the exposure duration was longer, the dose would rise proportionally. In addition, a person working at a truck service station could receive a significant dose if trucks were to use the same stops repeatedly. The dose to a person fueling a truck could be as much as 1 mrem. Administrative controls could be instituted to control the location and duration of truck stops if multiple exposures were to happen routinely.

Table E–7 Estimated Dose to Maximally Exposed Individuals During Incident-Free Transportation Conditions [a, b]

Receptor		***Dose to maximally exposed individual***
Workers	Crew Member	0.1 rem/yr[c]
	Inspector	0.0029 rem/event
Public	Resident	4.0×10^{-7} rem/event
	Person in Traffic Congestion	0.011 rem/event
	Person at Service Station	0.001 rem/event

[a] The exposure scenario assumptions are described in Section E.6.3.
[b] Doses are calculated assuming that the shipment external dose rate is equal to the maximum expected dose 10 mrem/hr at 2 m (3.3 ft) from the package.
[c] Dose to truck drivers could exceed the legal limit of 100 mrem/yr in the absence of administrative controls.

The cumulative dose to a resident was calculated assuming all shipments passed his or her home. The cumulative doses assume that the resident is present for every shipment and is unshielded at a distance of 30 m (66 ft) from the route. Therefore, the cumulative dose is only a function of the number of shipments passing a particular point and is independent of the actual route being considered. The maximum dose to this resident, if all the material were to be shipped via this route, would be less than 0.1 mrem. The annual individual dose can be estimated by assuming that shipments would occur uniformly over a 15-year time period.

The estimated dose to crew members (truck drivers) is presented for a commercial crew. No credit is taken for the shielding associated with the tractor or trailer.

The accident consequence assessment is intended to provide an estimate of the maximum potential impacts posed by the most severe potential transportation accidents involving a shipment. The accident consequence results are presented in **Table E–8** for the maximum severity accidents. The population doses are for a uniform population density within an 80-km (50-mi) radius (Neuhauser and Kanipe 1993). The location of the maximally exposed individual is determined based on atmospheric conditions at the time of the accident and the buoyant characteristics of the released plume. The locations of maximum exposure would be 100 m (330 ft) and 90 m (300 ft) from the accident site for neutral (average) and stable conditions, respectively. The dose to the maximally exposed individual is independent of the location of the accident. In general, the dose to maximally exposed individuals for the most severe accidents would be less than 10 mrem. No acute or early fatalities would be expected from radiological causes.

The maximum foreseeable (frequency greater than 1×10^{-7} per year) offsite transportation accident involves a shipment of scrub alloy in a suburban population zone under neutral (average) weather conditions. The accident has a probability of occurrence of about 1 every 10 million years and could result in 1.1 person-rem and no fatalities. The probability of an accident occurring is at least 10 times smaller in either an urban area or under stable atmospheric conditions, and the consequences are less than 10 times greater.

Table E–8 Estimated Dose to Maximally Exposed Individuals and the Population During the Specific Accident Conditions [a, b]

Mode and Accident Location	Neutral Conditions [c]				Stable Conditions [d]			
	Population [e]		Maximally Exposed Individual [f]		Population [e]		Maximally Exposed Individual [f]	
	Dose (person-rem)	Consequences (Cancer Fatalities)	Dose (rem)	Consequences (Probability of Cancer Fatality)	Dose (person-rem)	Consequences (Cancer Fatalities)	Dose (rem)	Consequences (Probability of Cancer Fatality)
Truck								
Urban	9.9	0.005	0.021	0.000015	4.7	0.0023	0.0018	8.85×10^{-7}
Suburban	1.1	0.00055	0.021	0.000015	0.8	0.0004	0.0018	8.85×10^{-7}
Rural	0.04	0.00002	0.021	0.000015	0.02	0.000009	0.0018	8.85×10^{-7}

[a] The most severe accidents correspond to the NUREG-0170 accident severity category VIII (NRC 1977).
[b] Buoyant plume rise resulting from fire for a severe accident was included in the exposure model.
[c] Neutral weather conditions result in moderate dispersion and dilution of the release plume. Neutral conditions were taken to be Pasquill stability Class D with a wind speed of 4 meters per second (m/sec) (9 miles per hour [mph]). Neutral conditions occur approximately 50 percent of the time in the United States.
[d] Stable weather conditions result in minimal dispersion and dilution of the release plume and are thus unfavorable. Stable conditions were taken to be Pasquill stability Class F with a wind speed of 1 m/sec (2.2 mph). Stable conditions occur approximately one-third of the time in the United States.
[e] Populations extend at a uniform density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation, acute cloudshine, groundshine, resuspended inhalation, resuspended cloudshine, and ingestion of food, including initially contaminated food (rural only) (Yuan et al. 1995). No decontamination or mitigative actions are taken.
[f] The maximally exposed individual is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 100 m (330 ft) and 90 m (300 ft) from the accident site under neutral and stable atmospheric conditions, respectively. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.

E.6.4 Analysis of Dispersal Risk Occurring in Transport Analysis

DOE analyzed the scrub alloy shipments to the Savannah River Site, and several selected shipments to Los Alamos National Laboratory using the Analysis of Dispersal Risk Occurring in Transport code. The purpose of this analysis was to show how much different the risk estimates would be if more credit were taken for the safe secure transport's inherent safety features. Note that the RADTRAN numbers in **Tables E–9** and **E–10** can be considered conservative for either safe secure or commercial transport. The Analysis of Dispersal Risk Occurring in Transport numbers are only conservative for safe secure transport.

Table E–9 Comparison of RADTRAN and Analysis of Dispersal Risk Occurring in Transport

Analysis of Dispersal Risk Occurring in Transport — Incident-free dose per shipment[1]					
Destination	*Workers*	*Public*			
		Off-road	*On-road*	*Stops*	*Total*
Savannah River Site	9.9×10^{-2}	4.2×10^{-3}	5.1×10^{-2}	2.8×10^{-2}	8.3×10^{-2}
Los Alamos National Laboratory	2.1×10^{-2}	1.3×10^{-3}	1.2×10^{-2}	6.0×10^{-3}	1.9×10^{-2}
RADTRAN — Incident-free dose per shipment[1]					
Savannah River Site	0.155	0.00146	0.0112	0.0860	0.0987
Los Alamos National Laboratory	0.0415	0.000365	0.00293	0.0241	0.0274

[1] Dose rate is assumed to be 10 mrem/hr at 2 meters.

Table E–10 Comparison of Accident "Risks" per Shipment

Code	*"Dose Risk" (person-rem) for Shipment to Savannah River Site*[1]	*Nonradiological Accidental Fatality Risk for Shipment to Savannah River Site*	*Nonradiological Accidental Fatality Risk for Shipment to Los Alamos National Laboratory*
ADROIT	1.0×10^{-7}	4.2×10^{-6}	1.1×10^{-6}
RADTRAN	1.4×10^{-5}	5.1×10^{-5}	3.7×10^{-6}

ADROIT = Analysis of Dispersal Risk Occurring in Transport

[1] Analysis of Dispersal Risk Occurring in Transport "dose-risk" computed using mean value for dose-health effects conversion factor (4.2×10^{-4} LCF/person-rem).

In Table E–9, the incident-free risk analysis results of RADTRAN and Analysis of Dispersal Risk Occurring in Transport are similar. The differences can be attributed to minor differences in the structure and definition of the models. However, as shown in Table E-10, the accident risk estimates of RADTRAN are much higher than those of Analysis of Dispersal Risk Occurring in Transport. This is because the RADTRAN analysis used commercial accident rates, and used standard commercial vehicle responses to accidents and fires. The Analysis of Dispersal Risk Occurring in Transport analysis took into account the extra capabilities of the safe, secure transports and the lower accident rate (Clauss 1994, Phillips 1994). Since the analytic approach of the two codes are different, input parameters cannot be directly compared.

E.6.5 Shipment of Transuranic Waste and Separated Plutonium

As described in Chapter 4, all processing of plutonium residues and scrub alloy generates transuranic waste and separated plutonium. The impacts of the transportation of transuranic waste and separated plutonium are covered in other EISs and are incorporated by reference into this EIS. However, for the convenience of the reader, the impacts related to material covered in this EIS (plutonium residues and scrub alloy) are summarized in the following sections.

E.6.5.1 Shipment of Transuranic Waste to the Waste Isolation Pilot Plant

The impacts of shipping this transuranic waste to WIPP are analyzed in the WIPP SEIS-II (DOE 1997). **Table E-11** shows the number of drums of transuranic waste generated from processing of plutonium residues and scrub alloy for the preferred alternative and Alternative 2. Using the fact that a truck shipment can carry three TRUPACT-II containers, and each TRUPACT-II container can carry 14 drums of transuranic waste, the number of shipments to WIPP is calculated and compared to the number of shipments analyzed in the WIPP SEIS-II (DOE 1997). As shown in Table E-11, the number of shipments to WIPP for material covered in this EIS are less than 20 percent of the total number of WIPP shipments from Rocky Flats, and less than 1 percent of the total number of WIPP shipments from the Savannah River Site and Los Alamos National Laboratory. Other alternatives considered in this EIS change the location of transuranic waste generated, and, to a lessor extent, the total amount of transuranic waste generated. Alternative 2 includes the disposition of scrub alloy through a calcination and vitrification process that was not envisioned at the time of the WIPP SEIS-II and, therefore, was not included in the WIPP SEIS-II. However, the impacts of transporting this material to WIPP can be estimated from information provided in Sections 4.11.1 and 4.15.2 of this EIS, and the WIPP SEIS-II, as shown in Table E-11.

Table E–11 Shipment Summary for Contact-Handled Transuranic Waste

Waste Origin Site	*Plutonium Residues and Scrub Alloy EIS Preferred Alternative*		*WIPP SEIS-II Proposed Action -Number of Shipments to WIPP*[a]	*Impacts Attributable to Plutonium Residue and Scrub Alloy (person-rem)*		
				Incident Free[b]		
	Number of Drums on Site	*Number of Shipments to WIPP*		*Worker*	*Public*	*Accident*[c]
Preferred Alternative						
Rocky Flats - Stabilized Residue - Secondary Transuranic	 17,600 2,300	 420 55	2,485	5	33	3
Savannah River Site	50	2	2,238	0.06	0.4	0.04
Los Alamos National Laboratory	900	22	5,009	0.1	0.9	0.03
Alternative 2						
Rocky Flats-Stabilized Scrub Alloy	2,748	66	0	1	5	0.4

[a] Taken from Table E-1 of the Waste Isolation Pilot Plant Disposal Phase Final Supplemental EIS (WIPP SEIS-II)(DOE 1997a)
[b] Calculated from the information in Table E-13 of the WIPP SEIS-II (DOE 1997a) multiplied by the number of shipments to WIPP related to plutonium residues and scrub alloy
[c] Calculated from the information in Tables E-1 and E-22 of WIPP SEIS-II (DOE 1997a) and the number of shipments to WIPP related to plutonium residues and scrub alloy

E.6.5.2 Separated Plutonium

The preferred alternative involves the separation of plutonium from the residues and scrub alloy at the Savannah River Site and at Los Alamos National Laboratory. This plutonium would become part of the surplus plutonium that was identified in the *Storage and Disposition of Weapons - Usable Fissile Materials Final Programmatic EIS* (DOE 1996a). Transportation impacts are analyzed in the *Surplus Plutonium Disposition Draft EIS* prepared by DOE's Office of Fissile Materials Disposition (DOE 1998). DOE estimates that less than 500 kg of plutonium will be separated at the Savannah River Site, and less than 150 kg of plutonium will be separated at the Los Alamos National Laboratory under the preferred alternative. This plutonium represents about one-third of the plutonium at the Savannah River Site and one-tenth of the plutonium at Los Alamos National Laboratory (DOE 1996a). This plutonium would be immobilized at either the Hanford Site or the Savannah River Site. Based on the *Surplus Plutonium Disposition Draft EIS* analyses, the maximum dose for transporting the separated plutonium to the crew and to the public would be less than one rem, and the maximum expected dose risk from accidents would be less than one millrem.

E.7 CONCLUSIONS AND LONG-TERM IMPACTS OF TRANSPORTATION

E.7.1 Conclusions

It is unlikely that transportation will cause an additional fatality. The nonradiological risks (air pollution and traffic accidents) are greater than the radiological risks.

E.7.2 Long-Term Impacts of Transportation

The *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995) analyzed the cumulative impacts of all transportation of radioactive materials, taking into account impacts from reasonably foreseeable actions that include transportation of radioactive material and general radioactive materials transportation that is not related to a particular action. The total worker and general population collective doses are summarized in **Table E–12**. Total collective worker doses from all types of shipments (historical, the alternatives, reasonably foreseeable actions, and general transportation) were estimated to be 320,000 person-rem (130 latent cancer fatalities) for the period of time 1943 through 2035 (93 years). Total general population collective doses were also estimated to be 320,000 person-rem (160 latent cancer fatalities). The majority of the collective dose for workers and the general population was due to the general transportation of radioactive material. Examples of these activities are shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial low-level radioactive waste to commercial disposal facilities. The total number of latent cancer fatalities estimated to result from radioactive materials transportation over the period between 1943 and 2035 was 290. Over this same period of time (93 years), approximately 28 million people would die from cancer, based on 300,000 cancer fatalities per year (NRC 1977). It should be noted that the estimated number of transportation-related latent cancer fatalities would be indistinguishable from other latent cancer fatalities, and the transportation-related latent cancer fatalities are 0.0010 percent of the total number of latent cancer fatalities.

Table E–12 Cumulative Transportation-Related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2035)

Category	*Collective Occupational Dose (person-rem)*	*Collective General Population Dose (person-rem)*
Shipment of Plutonium Residues and Scrub Alloy	< 100	< 100
Reasonably Foreseeable Actions		
Truck	11,000	50,000
Rail	820	1,700
General Transportation (1943–2035)	310,000	270,000
Total Collective Dose	320,000	320,000
Total latent cancer fatalities	130	160

Source: DOE 1995.

E.8 UNCERTAINTY AND CONSERVATISM IN ESTIMATED IMPACTS

The sequence of analyses performed to generate the estimates of radiological risk for the transportation includes: (1) determination of the inventory and characteristics, (2) estimation of shipment requirements, (3) determination of route characteristics, (4) calculation of radiation doses to exposed individuals (including estimation of environmental transport and uptake of radionuclides), and (5) estimation of health effects. Uncertainties are associated with each of these steps. Uncertainties exist in the way that the physical systems being analyzed are represented by the computational models, in the data required to exercise the models (due to measurement errors, sampling errors, natural variability, or unknowns simply caused by the future nature

of the actions being analyzed), and in the calculations themselves (e.g., approximate algorithms used by the computers).

In principle, one can estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result; however, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions to be initiated at an unspecified time in the future. Instead, the risk analysis is designed to ensure, through uniform and judicious selection of scenarios, models, and input parameters, that relative comparisons of risk among the various alternatives are meaningful. In the transportation risk assessment, this design is accomplished by uniformly applying common input parameters and assumptions to each alternative. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

In the following sections, areas of uncertainty are discussed for the assessment steps enumerated above. Special emphasis is placed on identifying whether the uncertainties affect relative or absolute measures of risk. The degree of reality conservatism of the assumption is addressed. Where practical, the parameters that most significantly affect the risk assessment results are identified.

E.8.1 Uncertainties in Plutonium Residue and Scrub Alloy Inventory and Characterization

The inventories and the physical and radiological characteristics are important input parameters to the transportation risk assessment. The potential amount of transportation for any alternative is determined primarily by the projected plutonium inventory and assumptions concerning shipment capacities. The physical and radiological characteristics are important in determining the amount of material released during accidents and the subsequent doses to exposed individuals through multiple environmental exposure pathways.

The development of projected plutonium inventory and characterization data used to support the EIS is described in Appendix B. Uncertainties in the inventory and characterization will be reflected to some degree in the transportation risk results. If the inventory is overestimated (or underestimated), the resulting transportation risk estimates also will be overestimated (or underestimated) by roughly the same factor. However, the same inventory estimates are used to analyze the transportation impacts of each of the EIS alternatives. Therefore, for comparative purposes, the observed differences in transportation risks among alternatives are believed to represent unbiased, reasonably accurate estimates from current information in terms of relative risk comparisons.

E.8.2 Uncertainties in Containers, Shipment Capacities, and Number of Shipments

The amount of transportation required for each alternative is based in part on assumptions concerning the packaging characteristics and shipment capacities for commercial trucks and safe secure transports. Representative shipment capacities have been defined for assessment purposes based on probable future shipment capacities. In reality, the actual shipment capacities may differ from the predicted capacities, so that the projected number of shipments, and consequently the total transportation risk, would change. However, although the predicted transportation risks would increase or decrease accordingly, the relative differences in risks among alternatives would remain about the same. The maximum amount of material allowed in Type B containers is set by conservative safety analyses, such as WSRC 1996.

E.8.3 Uncertainties in Route Determination

Representative routes have been determined between all origin and destination sites considered in the EIS. The routes have been determined consistent with current guidelines, regulations, and practices, but may not be the actual routes that would be used in the future. In reality, the actual routes could differ from the representative ones in terms of distances and total population along the routes. Moreover, since plutonium residues and scrub alloy could be transported over an extended period of time starting at some time in the future, the highway infrastructures and the demographics along routes could change. These effects have not been accounted for in the transportation assessment; however, it is not anticipated that these changes would significantly affect relative comparisons of risk among the alternatives considered in the EIS. Specific routes cannot be identified in advance for the Transportation Safeguards Division shipments because the routes are classified to protect national security interests.

E.8.4 Uncertainties in the Calculation of Radiation Doses

The models used to calculate radiation doses from transportation activities introduce a further uncertainty in the risk assessment process. It is generally difficult to estimate the accuracy or absolute uncertainty of the risk assessment results. The accuracy of the calculated results is closely related to the limitations of the computational models and to the uncertainties in each of the input parameters that the model requires. The single greatest limitation facing users of RADTRAN, or any computer code of this type, is the scarcity of data for certain input parameters. Parameters describing the location of people, traffic flows, weather, vehicle speed, and operational practices and radiological effects are estimated from "typical" information. They cannot be calculated from observed conditions on a certain route.

Uncertainties associated with the computational models are minimized by using state-of-the-art computer codes that have undergone extensive review. Because there are numerous uncertainties that are recognized but difficult to quantify, assumptions are made at each step of the risk assessment process that are intended to produce conservative results (i.e., overestimate the calculated dose and radiological risk). Because parameters and assumptions are applied to all alternatives, this model bias is not expected to affect the meaningfulness of relative comparisons of risk; however, the results may not represent risks in an absolute sense.

In order to understand the most important uncertainties and conservatism in the transportation risk assessment, the results for all cases were examined to identify the largest contributors to the collective population risk. The results of this examination are discussed briefly in the following paragraph.

For truck shipments, the largest contributors to the collective population dose, in decreasing order of importance, were found to be: (1) incident-free dose to members of the public at stops, (2) incident-free dose to transportation crew members, (3) incident-free dose to members of the public sharing the route (on-link dose), (4) incident-free dose to members of the public residing along the route (off-link dose), and (5) accident dose risk to members of the public. Approximately 80 percent of the estimated public dose was incurred at stops, 15 percent by the on-link population, and 5 percent by the off-link population. In general, the accident contribution to the total risk was negligible compared with the incident-free risks.

As shown above, incident-free transportation risks are the dominant component of the total transportation risk. The most important parameter in calculating incident-free doses is the shipment external dose rate (incident-free doses are directly proportional to the shipment external dose rate). For this assessment, it was assumed that all shipments would have an external dose rate at the regulatory limit of 10 mrem/hr at 2 m. In practice, the external dose rates would vary from shipment to shipment.

Finally, the single largest contributor to the collective population doses calculated with RADTRAN was found to be the dose to members of the public at truck stops. Currently, RADTRAN uses a simple point-source approximation for truck-stop exposures and assumes that the total stop time for a shipment is proportional to the shipment distance. The parameters used in the stop model were based on a survey of a very limited number of radioactive material shipments that examined a variety of shipment types in different areas of the country. It was assumed that stops occur as a function of distance, with a stop rate of 0.011 hour per km (0.018 hour per mi). It was further assumed that an average of 50 people at each stop are exposed at a distance of 20 m (66 ft). In RADTRAN, the population dose is directly proportional to the external shipment dose rate and the number of people exposed, and inversely proportional to the square of the distance. The stop rate assumed results in an hour of stop time per 100 km (62 mi) of travel.

Based upon the qualitative discussion with shippers, the parameter values used in the assessment appear to be conservative. However, data do not exist to quantitatively assess the degree of control, the location, frequency, and duration of truck stops. However, based on the regulatory requirements for continuous escort of the material (10 CFR Part 73) and the requirement for two drivers, it is clear that the trucks would be on the move much of the time until arrival at the destination. Therefore, the calculated impacts are extremely conservative. By using these conservative parameters, the calculations in this EIS are consistent with the RADTRAN default values.

Shielding of exposed populations is not considered. For all incident-free exposure scenarios, no credit has been taken for shielding of exposed individuals. In reality, shielding would be afforded by trucks and cars sharing the transport routes, rural topography, and the houses and buildings in which people reside. Incident-free exposure to external radiation could be reduced significantly depending on the type of shielding present. For residential houses, shielding factors (i.e., the ratio of shielded to unshielded exposure rates) have been estimated to range from 0.02 to 0.7, with a recommended value of 0.33. If shielding were to be considered for the maximally exposed resident living near a transport route, the calculated doses and risks would be reduced by approximately 70 percent. Similar levels of shielding may be provided to individuals exposed in vehicles. However, consideration of shielding does not significantly affect the overall incident-free risks to the general public.

Post-accident mitigative actions are not considered for dispersal accidents. For severe accidents involving the release and dispersal of radioactive materials in the environment, no post-accident mitigative actions, such as interdiction of crops or evacuation of the accident vicinity, have been considered in this risk assessment. In reality, mitigative actions would take place following an accident in accordance with U.S. Environmental Protection Agency (EPA) radiation protection guides for nuclear incidents (EPA 1991). The effects of mitigative actions on population accident doses are highly dependent upon the severity, location, and timing of the accident. For this risk assessment, ingestion doses are only calculated for accidents occurring in rural areas (the calculated ingestion doses, however, assumes all food grown on contaminated ground is consumed and is not limited to the rural population). Examination of the severe accident consequence assessment results has shown that ingestion of contaminated foodstuffs contributes on the order of 50 percent of the total population dose for rural accidents. Interdiction of foodstuffs would act to reduce, but not eliminate, this contribution.

E.9 REFERENCES

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APPENDIX F
ANALYSIS OF ENVIRONMENTAL JUSTICE

F.1 INTRODUCTION

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.

The Council on Environmental Quality has oversight responsibility for documentation prepared in compliance with the National Environmental Policy Act. In March 1997, the Council released updated draft guidance on environmental justice (CEQ 1997). The Council's guidance was adopted as the basis for the analysis of environmental justice contained in this Environmental Impact Statement (EIS).

F.2 DEFINITIONS AND APPROACH

The following definitions of minority individuals and population were used in this analysis of environmental justice:

- **Minority Individuals—**Persons who are members of any of the following population groups: Hispanic, Native American, Asian or Pacific Islander, or Black.

- **Minority Population—**The total number of minority individuals residing within a potentially affected area.

In the discussions of environmental justice in this document, persons self-designated as Hispanic are included in the Hispanic population regardless of race. The Asian or Pacific Islander population is comprised of persons self-designated as Asian or Pacific Islander and not of Hispanic origin. Asian or Pacific Islanders who designate themselves as having Hispanic origins are included in the Hispanic population. Data for the analysis of minorities were obtained from Table P12 of the Summary Tape File 3A published on CD-ROM by the United States Bureau of the Census (DOC 1992).

Executive Order 12898 specifically addresses "disproportionately high and adverse effects" on "low-income" populations. The Council recommends that poverty thresholds be used to identify "low-income" individuals.

The following definitions of low-income individuals and poverty-level population were used in this analysis:

- **Low-Income Individuals—**All persons whose self-reported income is less than the poverty threshold.

- **Low-Income Population—**The total number of poverty-level individuals residing within a potentially affected area.

Data for the analysis of low-income populations were extracted from Table P121 of Standard Tape File 3A (DOC 1992).

F.3 UNCERTAINTIES AND SPATIAL RESOLUTION

For the purposes of enumeration and analysis, the Census Bureau has defined a variety of areal units (DOC 1992). Areal units of concern in this document include (in order of increasing spatial resolution): States, counties, census tracts, block groups, and blocks. The "block" is generally the smallest of these entities and offers the finest spatial resolution. This term refers to a relatively small geographical area bounded on all sides by visible features such as streets and streams, or by invisible boundaries such as city limits and property lines. During the 1990 census, the Bureau subdivided the United States and its territories into 7,017,425 blocks. For comparison the number of counties, census tracts, and block groups used in the 1990 census were 3,248; 62,276; and 229,192; respectively. While blocks offer the finest spatial resolution, economic data required for identification of low-income populations are not available at the block-level of spatial resolution. In the analysis below, block groups are used throughout as the areal unit.

The initial step in an analysis of environmental justice is to identify minority populations and low-income populations residing within areas potentially affected by the proposed action and alternatives. In this analysis, potentially affected areas were defined as those areas which could be impacted by radiological effects or chemical releases. For example, radiological and chemical release impacts were evaluated in Chapter 4 of this document for persons residing within 80 kilometers (km) (50 miles [mi]) of management sites. Analyses were also performed for non-accident transportation of plutonium residues along highways from the Rocky Flats Environmental Technology Site (Rocky Flats) to the Savannah River Site and Los Alamos National Laboratory.

As discussed in Chapter 4, alternatives in this EIS are not likely to harm water quality or wildlife. It is unlikely that implementation of any of the alternatives would harm persons who rely on fish or other wildlife for subsistence.

F.4 RESULTS FOR DEPARTMENT OF ENERGY (DOE) SITES

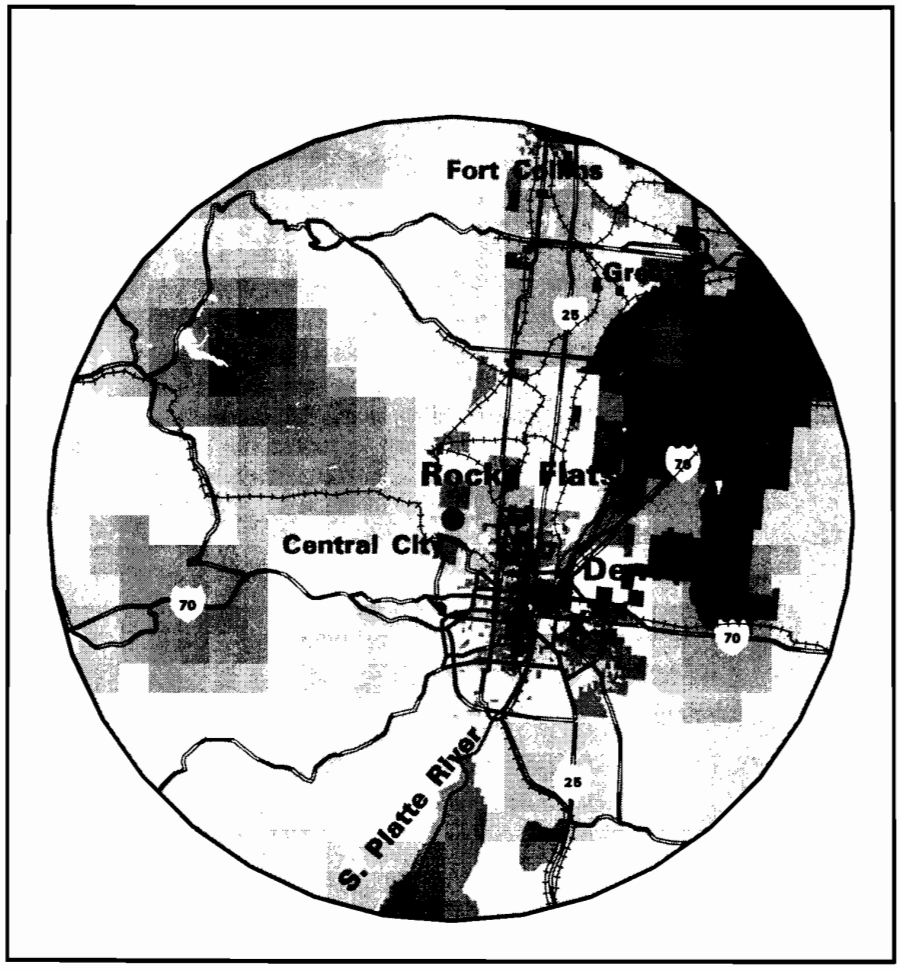
Table F-1 shows the total population, minority population, and percentage minority population that resided within 80 km (50 mi) of the various DOE sites at the time of the 1990 census. The 80-km (50-mi) distance defines the radius of potential radiological effects, described in Chapter 4 of this EIS, for calculations of radiation dose to the general population from the proposed action. Columns 5 through 7 of the table show similar data for the summation of populations over all counties having boundaries that lie at least partly within a circle of the 80-km (50-mi) radius centered at each site.

Table F–1 Minority Populations Residing Within and Near Potentially Affected Areas

Site	*Population Within 80 km of Site*	*Minority Population Within 80 km of Site*	*% Minority Population Within 80 km of Site*	*Population in Counties Surrounding Site*	*Minority Population in Counties Surrounding Site*	*% Minority Population in Counties Surrounding Site*
Rocky Flats	2,165,727	414,505	19.1	2,214,399	418,802	18.9
Los Alamos National Laboratory	214,290	116,091	54.2	748,429	368,785	49.3
Savannah River Site	613,087	233,177	38.0	944,982	330,078	34.9

In 1990, the minority population residing in the contiguous United States constituted 24.2 percent of the total population. The States of Georgia, New Mexico, and South Carolina are among the 10 contiguous States with

the largest percent minority populations. **Figures F-1** through **F-3** show the geographical distribution of



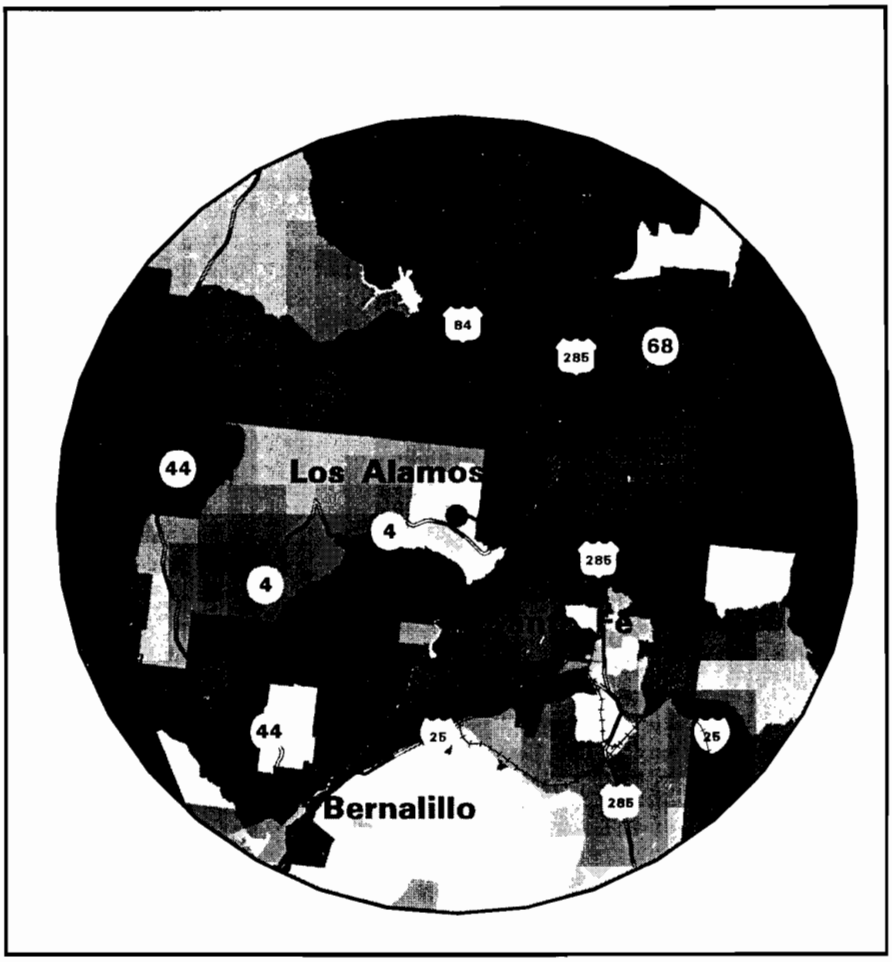
LEGEND

- Site
- Surface Water Shoreline
- Rail Lines
- State & US Highways
- 0 <= Pm < 12%
- 12% <= Pm < 24%
- 24% <= Pm < 48%
- Pm >= 48%

SUMMARY STATISTICS	
WITHIN 80 KM (50 MILES) RADIUS OF THE SITE	
TOTAL POPULATION	2,165,727
MINORITY POPULATION	414,905
PERCENTAGE	19%

0 5 10 15 20 25 30
miles

Figure F–1 Minority Population Residing Within 80 km (50 mi) of the Rocky Flats Environmental Technology Site



LEGEND

- Site
- Surface Water Shoreline
- Rail Lines
- State & US Highways

- 0 <= Pm < 12%
- 12% <= Pm < 24%
- 24% <= Pm < 48%
- Pm >= 48%

SUMMARY STATISTICS	
WITHIN 80 KM (50 MILES) RADIUS OF THE SITE	
TOTAL POPULATION	214,290
MINORITY POPULATION	116,091
PERCENTAGE	54%

0 5 10 15 20 25 30
miles

Figure F–2 Minority Population Residing Within 80 km (50 mi) of the Los Alamos National Laboratory

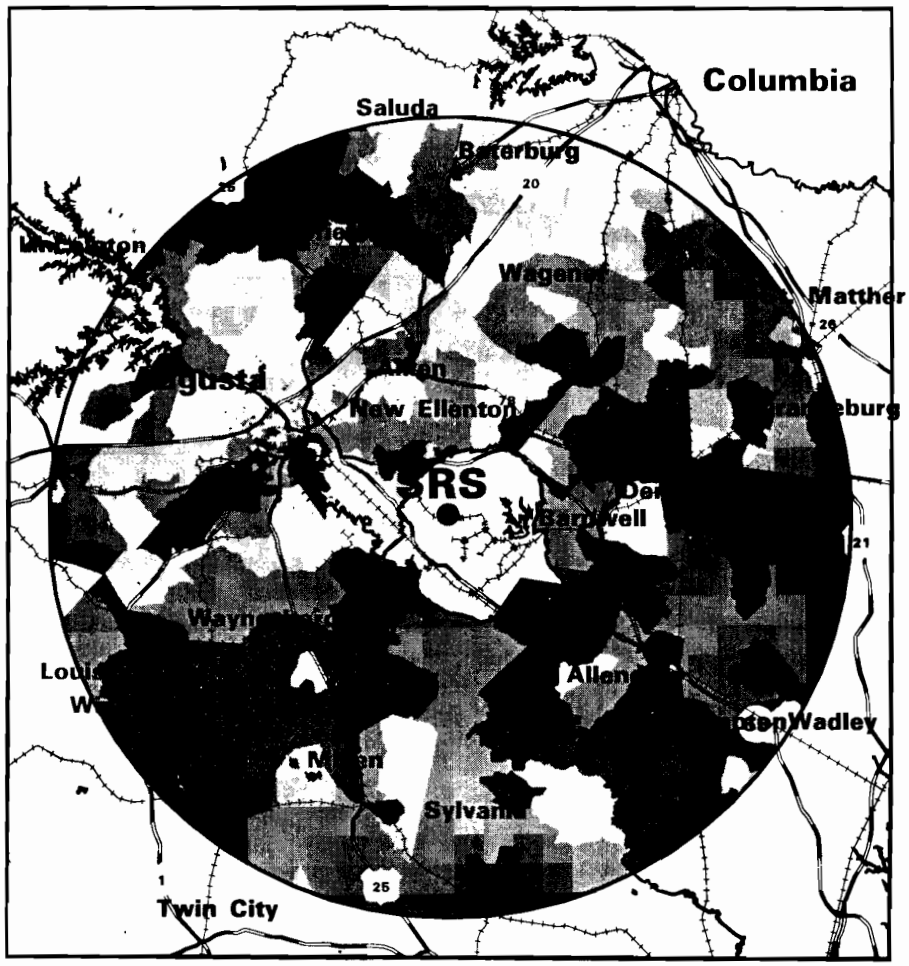


Figure F–3 Minority Population Residing Within 80 km (50 mi) of the Savannah River Site

minority populations surrounding the three sites. **Table F-2** shows the racial and ethnic composition of the population residing near the three sites.

Table F-3 and **Figures F-4** through **F-6** characterize low-income populations residing near the three sites. The national percentage of persons with income below the poverty threshold residing in the contiguous States was 12.8 percent at the time of the 1990 census. The percentages of persons in poverty in the States of Colorado, New Mexico, and South Carolina during the 1990 census were 11.4 percent, 20.2 percent, and 14.9 percent, respectively. The Bureau of the Census estimates that by 1995 these percentages increased to 25.3 percent and 19.9 percent for New Mexico and South Carolina, respectively, while the percentage for Colorado declined to 8.8 percent (Baugher and Lamison-White 1996).

F.5 RESULTS FOR TRANSPORTATION ROUTES

Overland transportation of plutonium residues and scrub alloy involves radiological and nonradiological risks to the public. **Tables F-4** and **F-5** show minority and low-income populations residing along highway routes from Rocky Flats to the Los Alamos National Laboratory and the Savannah River Site. Columns 2 and 3 of these tables show populations residing within a 1.6 km (1 mi) corridor centered along highway routes from Rocky Flats to candidate interim management sites. Columns 5 and 6 display the minority and low-income populations in counties which contain the highway routes. Data presented in the tables were resolved at the block-group level.

Percentage minority populations residing in the corridors exceed those in the counties surrounding the corridors and also exceed the national minority percentage population of 24.2 percent for the contiguous United States. With the exception of the route from Rocky Flats to Los Alamos National Laboratory, the percentage poverty-level population residing in the corridors is less than the national percentage of 13.3 percent, but higher than the percentage for the surrounding counties. The distances along highway routes connecting Rocky Flats with other candidate management sites are as follows: 759 km (472 mi) (Los Alamos National Laboratory), and 2,588.1 km (1,609 mi) (Savannah River Site).

As discussed in Sections E.6.2 and E.6.3 of Appendix E, it is unlikely that radiological or nonradiological harm to the public would result from highway transportation of plutonium residues and scrub alloy. The highway transportation of plutonium residues and scrub alloy would not likely harm any particular group within the general population, including low-income populations and minority populations.

Table F–2 Racial and Ethnic Composition of Minority Populations Residing Within 80 km (50 mi) of Potential Sites

Site	*Total Pop.*	*Total Minority Pop.*	*% Minority Pop.*	*American Indian, Eskimo, or Aleut Pop.*	*% American Indian, Eskimo, or Aleut Pop.*	*Asian or Pacific Islander Pop.*	*% Asian or Pacific Islander Pop.*	*Black Pop.*	*% Black Pop.*	*Hispanic Origin Pop.*	*% Hispanic Origin Pop.*
Rocky Flats	2,165,727	414,505	19.1	12,075	0.6	44,567	2.1	95,161	4.4	260,441	12.0
Los Alamos National Laboratory	214,290	116,091	54.2	15,081	7.0	1,242	0.6	1,306	0.6	97,897	45.7
Savannah River Site	613,087	233,177	38.0	1,533	0.3	5,885	1.0	219,317	35.8	6,442	1.1

Table F–3 Low-Income Populations Residing Within and Near Potentially Affected Areas

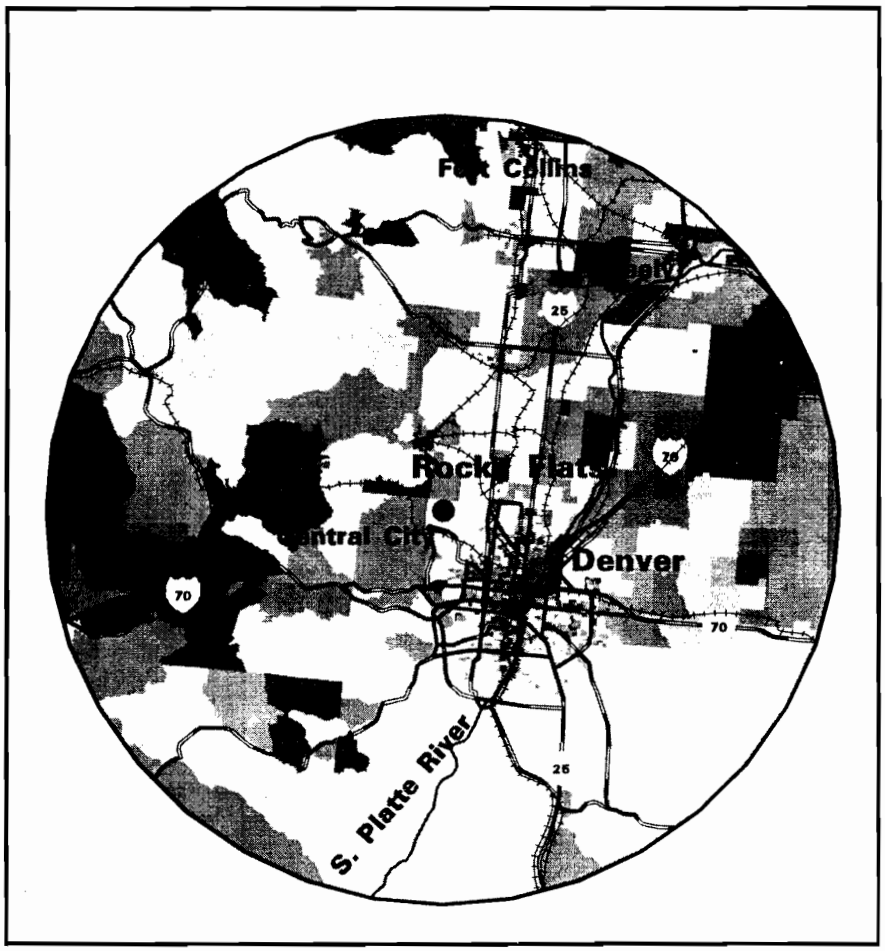
Site	*Population Within 80 km of Site*	*Low-Income Population Within 80 km of Site*	*% Low-Income Population Within 80 km of Site*	*Population in Counties Surrounding Site*	*Low-Income Population in Counties Surrounding Site*	*% Low-Income Population in Counties Surrounding Site*
Rocky Flats	2,165,727	219,263	10.1	2,214,399	224,455	10.1
Los Alamos National Laboratory	214,290	31,542	14.7	748,429	116,298	15.5
Savannah River Site	613,087	107,067	17.5	944,982	171,577	18.2

Table F–4 Minority Populations Residing Near Highway Routes from Rocky Flats to Candidate Management Sites

Destination	*Population Along Route*	*Minority Population Along Route*	*% Minority Population Along Route*	*Population in Counties Surrounding the Route*	*Minority Population in Counties Surrounding the Route*	*% Minority Population in Counties Surrounding the Route*
Los Alamos National Laboratory	183,618	60,200	32.8	2,611,159	616,483	23.6
Savannah River Site	561,135	145,540	25.9	9,850,030	2,305,994	23.4

Table F–5 Low-Income Populations Residing Along Highway Routes from Rocky Flats to Candidate Management Sites

Destination	*Population Along Route*	*Low-Income Population Along Route*	*% Low-Income Population Along Route*	*Population in Counties Surrounding the Route*	*Low-Income Population in Counties Surrounding the Route*	*% Low-Income Population in Counties Surrounding the Route*
Los Alamos National Laboratory	183,618	30,486	16.6	2,611,159	282,207	10.8
Savannah River Site	561,135	69,980	12.5	9,850,030	1,157,059	11.7



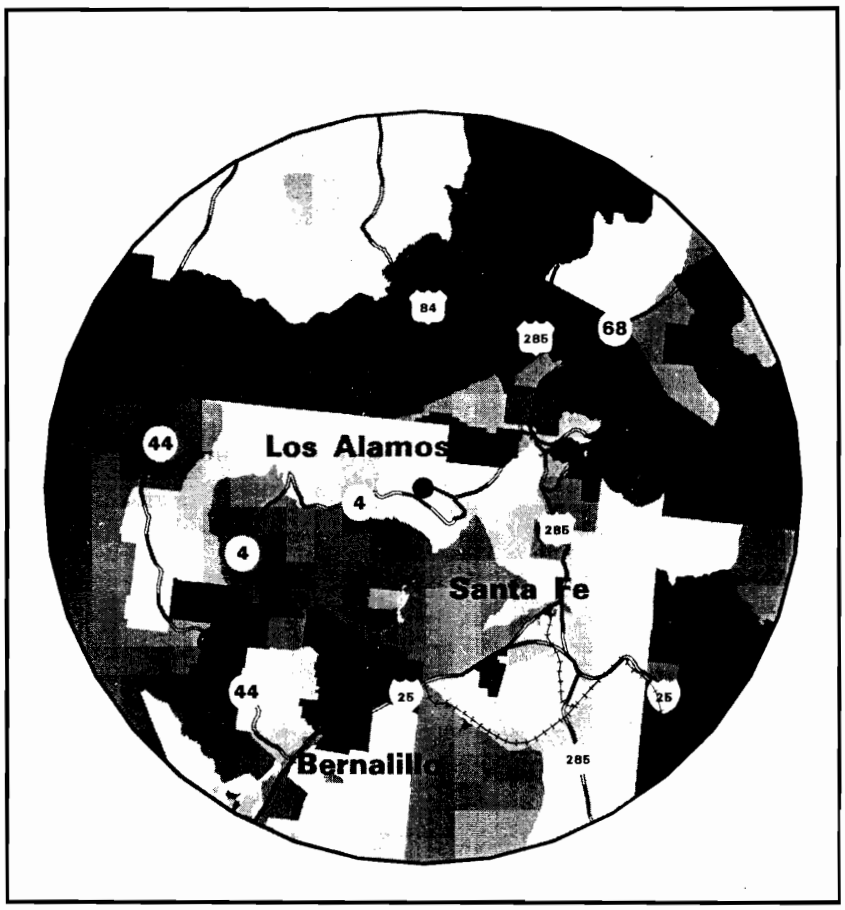
LEGEND

- Site
- Surface Water Shoreline
- Rail Lines
- State & US Highways
- 0 <= Pp < 6.5%
- 6.5% <= Pp < 13%
- 13% <= Pp < 26%
- Pp >= 26%

SUMMARY STATISTICS	
WITHIN 80 KM (50 MILES) RADIUS OF THE SITE	
TOTAL POPULATION	2,165,727
POVERTY-LEVEL POPULATION	219,263
PERCENTAGE	10%

0 5 10 15 20 25 30
miles

Figure F–4 Low-Income Population Residing Within 80 km (50 mi) of the Rocky Flats Environmental Technology Site



LEGEND

- Site
- Surface Water Shoreline
- Rail Lines
- State & US Highways
- 0 <= Pp < 6.5%
- 6.5% <= Pp < 13%
- 13% <= Pp < 26%
- Pp >= 26%

SUMMARY STATISTICS

WITHIN 80 KM (50 MILES) RADIUS OF THE SITE	
TOTAL POPULATION	214,290
POVERTY-LEVEL POPULATION	31,542
PERCENTAGE	15%

0 5 10 15 20 25 30
miles

Figure F–5 Low-Income Population Residing Within 80 km (50 mi) of the Los Alamos National Laboratory

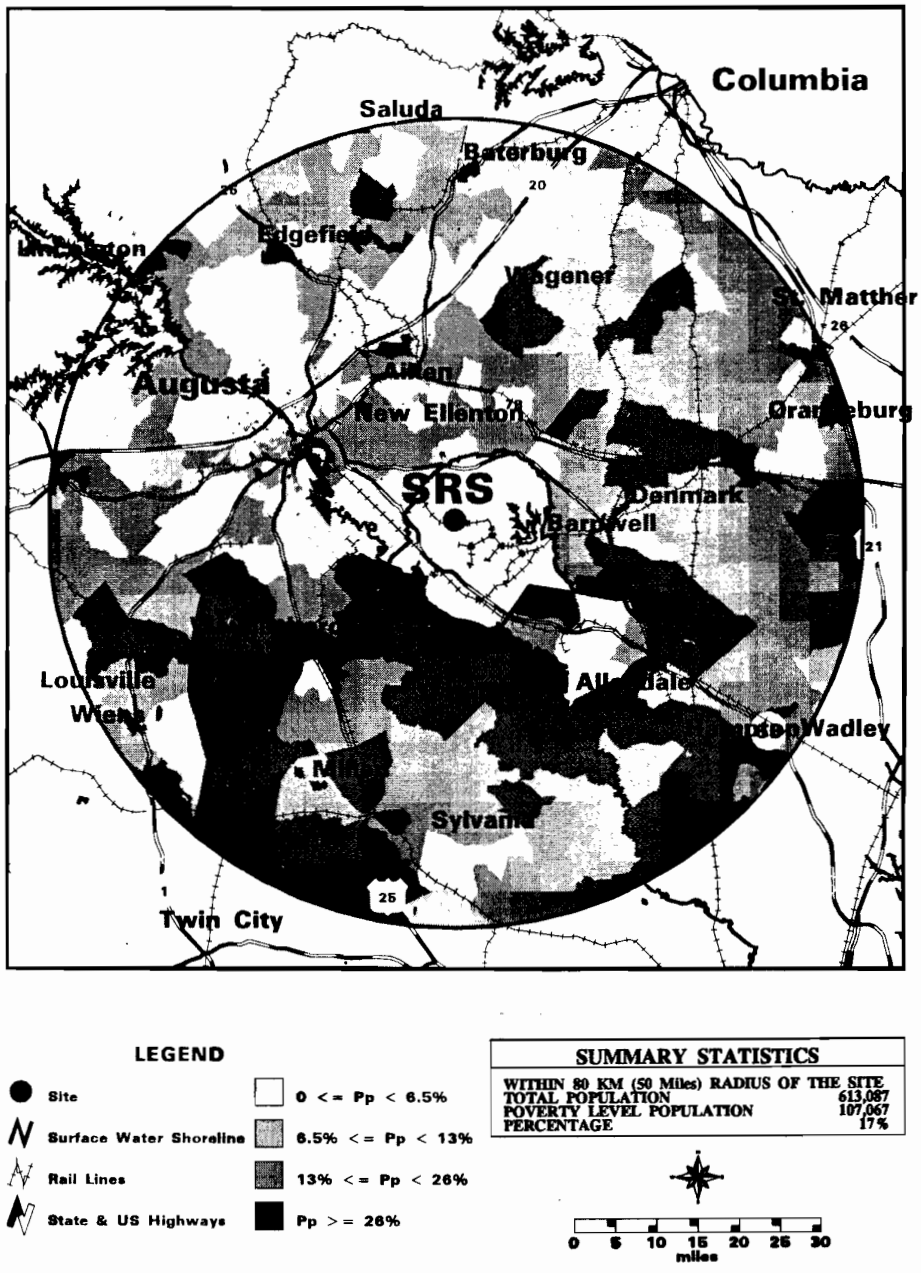


Figure F–6 Low-Income Population Residing Within 80 km (50 mi) of the Savannah River Site

F.6 REFERENCES

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APPENDIX G
COST ANALYSES

This appendix provides supporting data and calculations for Section 4.17 of this Environmental Impact Statement (EIS). It contains five major sections: G.1 Cost Estimating Bases, G.2 Processing Durations and Schedules, G.3 Major Schedule Uncertainties, G.4 Availability and Capability of DOE Facilities, and G.5 Estimated Absolute and Incremental Costs for Each Processing Option. The objective is to support the estimates of total and incremental costs, schedule durations, and uncertainties.

G.1 COST ESTIMATING BASES

This section describes the cost estimating bases used in this EIS. It is divided into the following six parts:

- Facilities and Equipment Costs
- Labor and Site Overhead Costs
- Transuranic Waste Costs, Including Variable Costs of Disposal at WIPP
- Low-level Waste Costs at Rocky Flats and Los Alamos National Laboratory
- Other Materials Storage, Shipping, and Disposal Costs, Including Costs at the Savannah River Site
- Costs Related to Interim Storage of Stabilized Residue and Transuranic Waste at Rocky Flats.

G.1.1 Facilities and Equipment Costs

Facilities and equipment costs are divided into two groups: (1) costs that have been incurred, are being incurred, or will be incurred in support of the plutonium residues clean-up independent of the Record of Decision in the present EIS, and (2) costs that will be incurred pursuant to the Record of Decision in the present EIS. The former group includes costs to bring the facilities into compliance with DOE regulations and Defense Nuclear Facilities Safety Board recommendations, to upgrade the facilities for their missions, to install facility-specific equipment, and to complete operational readiness reviews and startup tests. These common costs, plus ongoing research and development costs, are allocable to the plutonium residues program, but are not incremental (i.e., decisional) in the present EIS. Allocable costs in most alternatives are $180 million for facilities and equipment ($30 million per facility at Rocky Flats and an average of six facilities) and $10 million for research and development. Processing costs are based on facilities and equipment that are (or would be) up-and-running for this program rather than on developmental technologies. Decommissioning costs at all three sites are part of site-wide programs outside the scope of this EIS

Costs for expensive, specialized pieces of equipment that would not be purchased except for specific processing options in this EIS are directly assigned to these options. These costs, which are incremental to existing DOE budgets and decisional in this EIS, consist of:

- $30 million for two Silver II electrochemical dissolvers for mediated electrochemical oxidation of incinerator ash, graphite fines, graphite, or inorganic residues at the Savannah River Site F-Canyon or H-Canyon, (WSRC 1997) or at Rocky Flats.

- $20 million for pre-installation decontamination and decommissioning of highly contaminated equipment at HB-Line for mediated electrochemical oxidation of incinerator ash, graphite fines, graphite, or inorganic residues at the Savannah River Site H-Canyon (WSRC 1997).

- $4 million for distillation equipment at Rocky Flats for IDC 409 electrorefining and molten salt extraction salt residues or other electrorefining and molten salt extraction salts (DOE 1996c).

- $37 million for distillation equipment at Los Alamos National Laboratory for IDC 409 electrorefining and molten salt extraction salt residues (LANL 1998).

- $115 million for distillation equipment and vault upgrades at Los Alamos National Laboratory for other electrorefining and molten salt extraction salts (LANL 1998).

- $1.75 million for cold ceramification equipment at Rocky Flats for incinerator ash; sand, slag, and crucible; graphite fines, and inorganic ash..

Because it is not possible to allocate shared equipment costs to individual processing options except as part of a complete alternative, equipment costs that could be shared are excluded from the summary costs on Table G-12. Equipment and vault upgrade costs at Los Alamos National Laboratory for distillation of electrorefining and molten salt extraction salts ($37 million for IDC 409 residues and $115 million for other residues) are included on the summary tables since these costs are not shared.

Table G–1 shows the Rocky Flats facilities used in the No Action Alternative. These facilities are Modules A, D, E, F and J in Building 707 and Room 3701 in Building 371. These facilities, plus Building 707 Module B and Building 371 Room 3305 (used in scrubbing, distilling, or water leaching salt residues) represent all the facilities at Rocky Flats proposed for use in this EIS. This EIS assumes that facilities-related upgrades, compliance with Defense Nuclear Facilities Safety Board recommendations, etc., will take place independent of the decisions made in this EIS. Thus, common costs at these facilities are not incremental to the No Action Alternative or incremental to DOE. For rooms or modules at Building 371 or Building 707 that may be used in an alternative but are not used in the No Action Alternative, this approach understates the actual cost of the alternative. This understatement may be material but is difficult to calculate without analyzing site-wide facilities plans. This level of detail is beyond the scope of the present EIS.

Table G-2 shows projected fiscal-year 1998 development and testing expenditures at Rocky Flats and Los Alamos National Laboratory for processing options identified in the present EIS. These expenditures are independent the Record of Decision in the present EIS. Total spending is estimated at about $10 million for the fiscal year. Although development and testing work is ongoing at Rocky Flats and Los Alamos National Laboratory, all processing costs are based on facilities and equipment that are (or will be) up-and-running at production scale for this program, rather than on developmental or bench-scale technologies.

G.1.2 Labor and Site Overhead Costs

Labor and site overhead costs are estimated as a function of the number of hours that operations and support personnel are exposed to radiation (not the amount of radiation they are exposed to). These exposure-hours are then multiplied by a factor that relates allocable labor hours at the site to exposure-hours. The more allocable labor-hours per exposure-hour, the greater the multiplier. The multiplier captures the hours spent by: (1) exposed individuals in non-exposed activities (e.g., preparing for operations, down-time during maintenance, and administrative matters), (2) non-exposed individuals in direct support of the operations, and

(3) indirect site support personnel. The relationships between exposure-hours and allocable labor costs are based on empirical observations from a sample of recent residues management activities at Rocky Flats.

Table G–1 Facilities Required for No Action Alternative

No Action Processing Option	*Facilities*	*Number of No Action Processing Options at the Facility or Facilities*
Calcine and Cement Incinerator Ash	371–3701	13
Calcine and Cement Sand, Slag, and Crucible	371–3701	13
Cement Graphite Fines	371–3701	13
Calcine and Cement Inorganic Ash	371-3701	13
Pyro-Oxidize IDC 409 Electrorefining and Molten Salt Extraction Salts	707A, 707B, 707D, 707E	4,4,8,8
Pyro-Oxidize Other Electrorefining and Molten Salt Extraction Salts	707A, 707B, 707D, 707E	4,4,8,8
Pyro-Oxidize IDC 365, 413, and 427 Direct Oxide Reduction Salts	707A, 707B, 707D, 707E	4,4,8,8
Pyro-Oxidize Other Direct Oxide Reduction Salts	707A, 707B, 707D, 707E	4,4,8,8
Neutralize/Dry Aqueous Contaminated-Combustibles	371–3701	13
Thermal Desorption Organic-Contaminated Combustibles	371–3701	13
Direct Repackage Dry Combustibles	707D, 707E, 707F	8,8,3
Acid Dissolve Plutonium Fluorides	707J, 371–3701	1,13
Neutralize/Dry IDC 331 Ful Flo Filters	371-3701	13
Neutralize/Dry IDC 338 High-Efficiency Particulate Air Filters	371–3701	13
Neutralize/Dry Other High-Efficiency Particulate Air Filters	371–3701	13
Filter/Dry Sludge	371–3701	13
Neutralize/Dry Glass	371–3701	13
Repackage Graphite	707D, 707E, 707F	8,8,3
Repackage Inorganics	707D, 707E, 707F	8,8,3
Repackage Scrub Alloy	707D, 707E	8,8

Table G–2 Development And Testing Costs for Rocky Flats and Los Alamos National Laboratory Processing Technologies

Technology	*Cost ($000)*
Cementation	500
Calcination/Vitrification (except Scrub Alloy)	645
Calcination/Vitrification (Scrub Alloy)	500
Neutralize/Dry	81
Blend Down	250
Acid Dissolve Plutonium Oxide Recovery	200
Catalytic Chemical Oxidation	2,000
Sonic Wash	1,000
Mediated Electrochemical Oxidation	2,000
Salt Distillation	2,000
Salt Scrub	500
Water Leach	500

The following steps describe the process used to develop the exposure-hour multipliers (SAIC 1997a):

- Identify total labor costs previously developed at Rocky Flats for work scheduled under certain processing options for fiscal year 1998. Labor cost estimates were available for distillation of salt residue, sonic wash of wet combustibles, repackaging of dry combustibles, and vitrification of ash (incinerator ash, graphite fines, and sand, slag, and crucible).

- Divide total annual labor costs by $100,000 per person-year, resulting in an estimate of the number of full-time equivalent personnel for each processing option per year.

- Divide annual full-time equivalent personnel by annual personnel exposure (calculated separately). The result is the ratio of personnel-hours to exposure-hours for each processing option. For the four specified residue categories and processing options, the resulting ratios were salt distillation, 3.1; sonic wash wet combustibles, 5.8; repackage dry combustibles, 1.1; and vitrify ash, 4.2.

- Apply the calculated exposure-hour multipliers to the other processing options according to the similarity of the options (e.g., vitrification and blending are estimated at 4.2, distillation and pyro-oxidation are estimated at 3.1). **Tables G–3** and **G–4** show the complete estimates for Rocky Flats and the Savannah River Site, respectively. Costs at the Los Alamos National Laboratory are similar to those at Rocky Flats for the same types of activities.

Table G–3 Exposure-Years, Person-Year Multiplier, Allocable Labor Costs (Dollars in Millions) at Rocky Flats

Material	*Process*	*Exposure Years*	*Multiplier*	*Labor Costs*
Incinerator Ash	Calcine & Cement at Rocky Flats	190	5.8	110
Incinerator Ash	Vitrification at Rocky Flats	82	4.2	34
Incinerator Ash	Cold Ceramification at Rocky Flats	58	5.8	34
Incinerator Ash	Blend Down at Rocky Flats	123	4.2	52
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site F-Canyon	76	1.1	8
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site H-Canyon	76	1.1	8
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	54	1.1	6
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	54	1.1	6
Incinerator Ash	Calcine & Cement at Rocky Flats (Alternative 4)	189	5.8	110
Incinerator Ash	Repackage at Rocky Flats (Alternative 4)	38	1.1	4
Sand, slag, & crucible	Calcine & Cement at Rocky Flats	27	5.8	16
Sand, slag, & crucible	Vitrification at Rocky Flats	12	4.2	5
Sand, slag, & crucible	Blend Down at Rocky Flats	17	4.2	7
Sand, slag, & crucible	Repackage and Purex process at the Savannah River Site F-Canyon	9	1.1	1
Sand, slag, & crucible	Repackage and Purex process at the Savannah River Site H-Canyon	9	1.1	1
Sand, slag, & crucible	Calcine & Cement at Rocky Flats (Alternative 4)	28	5.8	16

Material	*Process*	*Exposure Years*	*Multiplier*	*Labor Costs*
Sand, slag, & crucible	Repackage at Rocky Flats (Alternative 4)	5	1.1	1
Graphite Fines	Cement at Rocky Flats	12	5.8	7
Graphite Fines	Vitrification at Rocky Flats	7	4.2	3
Graphite Fines	Blend Down at Rocky Flats	8	4.2	3
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	4	1.1	0
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	4	1.1	0
Graphite Fines	Cement at Rocky Flats (Alternative 4)	12	5.8	7
Graphite Fines	Repackage at Rocky Flats (Alternative 4)	3	1.1	0
Inorganic Ash	Calcine & Cement at Rocky Flats	11	5.8	6
Inorganic Ash	Vitrification at Rocky Flats	5	4.2	2
Inorganic Ash	Blend Down at Rocky Flats	7	4.2	3
Inorganic Ash	Calcine & Cement at Rocky Flats (Alternative 4)	11	5.8	6
Inorganic Ash	Repackage at Rocky Flats (Alternative 4)	2	1.1	0
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats	37	3.1	12
MSE/ER Salts (IDC 409)	Blend Down at Rocky Flats	71	4.2	30
MSE/ER Salts (IDC 409)	Distillation at Rocky Flats	24	3.1	7
MSE/ER Salts (IDC 409)	Water Leach at Rocky Flats	46	5.8	27
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats and distillation at Los Alamos National Laboratory	18	3.1	5
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	21	3.1	6
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	21	3.1	6
MSE/ER Salts (IDC 409)	Pyro-oxidize, Blend, Repackage (Alternative 4)	18	4.2	8
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats	91	3.1	28
MSE/ER Salts (All Others)	Blend Down at Rocky Flats	173	4.2	73
MSE/ER Salts (All Others)	Distillation at Rocky Flats	57	3.1	18
MSE/ER Salts (All Others)	Water Leach at Rocky Flats	112	5.8	65
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats and distillation at Los Alamos National Laboratory	43	3.1	13
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	51	3.1	16
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	51	3.1	16
MSE/ER Salts (All Others)	Pyro-oxidize (Alternative 4)	87	3.1	27
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats	39	3.1	12
DOR Salts (IDCs 365, 413, 427)	Blend Down at Rocky Flats	42	4.2	18
DOR Salts (IDCs 365, 413, 427)	Water Leach at Rocky Flats	28	5.8	16
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	3	3.1	1

Material	*Process*	*Exposure Years*	*Multiplier*	*Labor Costs*
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	3	3.1	1
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	12	3.1	4
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	12	3.1	4
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize, Blend, Repackage (Alternative 4)	11	4.2	4
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats	14	3.1	4
DOR Salts (All Others)	Blend Down at Rocky Flats	15	3.1	5
DOR Salts (All Others)	Water Leach at Rocky Flats	10	5.8	6
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	1	3.1	0
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	1	3.1	0
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	4	3.1	1
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	4	3.1	1
DOR Salts (All Others)	Pyro-oxidize (Alternative 4)	14	3.1	4
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats	3	5.8	2
Aqueous-Contaminated Combustibles	Sonic Wash at Rocky Flats	4	5.8	2
Aqueous-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	12	5.8	7
Aqueous-Contaminated Combustibles	Blend Down at Rocky Flats	1	4.2	1
Aqueous-Contaminated Combustibles	Mediated Electrochemical Oxidation	3	5.8	2
Aqueous-Contaminated Combustibles	Neutralize/Dry (Alternative 4)	3	5.8	2
Organic-Contaminated Combustibles	Thermal Desorption/Steam Passivation at Rocky Flats	6	5.8	3
Organic-Contaminated Combustibles	Sonic Wash at Rocky Flats	3	5.8	2
Organic-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	9	5.8	5
Organic-Contaminated Combustibles	Blend Down at Rocky Flats	1	4.2	0
Organic-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	2	5.8	1
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation (Alternative 4)	6	5.8	3
Dry Combustibles	Repackage at Rocky Flats	1	1.1	0
Dry Combustibles	Sonic Wash at Rocky Flats	2	5.8	1
Dry Combustibles	Catalytic Chemical Oxidation at Rocky Flats	7	5.8	4
Dry Combustibles	Blend Down at Rocky Flats	1	4.2	0

Material	*Process*	*Exposure Years*	*Multiplier*	*Labor Costs*
Dry Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	2	5.8	1
Dry Combustibles	Repackage at Rocky Flats (Alternative 4)	1	1.1	0
Plutonium Fluorides	Acid Dissolution at Rocky Flats	22	5.8	13
Plutonium Fluorides	Blend Down at Rocky Flats	56	4.2	23
Plutonium Fluorides	Acid Dissolution at Rocky Flats	22	5.8	13
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	4	1.1	0
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	4	1.1	0
Ful Flo Filter Media	Neutralize/Dry at Rocky Flats	5	5.8	3
Ful Flo Filter Media	Blend Down at Rocky Flats	2	4.2	1
Ful Flo Filter Media	Sonic Wash at Rocky Flats	4	5.8	2
Ful Flo Filter Media	Mediated Electrochemical Oxidation at Rocky Flats	3	5.8	2
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats	22	5.8	13
HEPA Filters (IDC 338)	Vitrification at Rocky Flats	10	4.2	4
HEPA Filters (IDC 338)	Blend Down at Rocky Flats	11	4.2	5
HEPA Filters (IDC 338)	Sonic Wash at Rocky Flats	19	5.8	11
HEPA Filters (IDC 338)	Mediated Electrochemical Oxidation at Rocky Flats	14	5.8	8
HEPA Filters (IDC 338)	Neutralize/Dry (Alternative 4)	22	5.8	13
HEPA Filters (All Others)	Neutralize/Dry at Rocky Flats	0	5.8	0
HEPA Filters (All Others)	Vitrification at Rocky Flats	0	4.2	0
HEPA Filters (All Others)	Blend Down at Rocky Flats	1	4.2	0
HEPA Filters (All Others)	Sonic Wash at Rocky Flats	0	5.8	0
HEPA Filters (All Others)	Mediated Electrochemical Oxidation at Rocky Flats	0	5.8	0
HEPA Filters (All Others)	Blend and Repackage at Rocky Flats (Alternative 4)	1	4.2	0
Sludge (IDCs 089, 099, 332)	Filter/Dry at Rocky Flats	0	5.8	0
Sludge (IDCs 089, 099, 332)	Vitrification at Rocky Flats	0	4.2	0
Sludge (IDCs 089, 099, 332)	Blend Down at Rocky Flats	0	4.2	0
Sludge (IDCs 089, 099, 332)	Blend and Repackage at Rocky Flats (Alternative 4)	0	4.2	0
Sludge (All Others)	Filter/Dry at Rocky Flats	5	5.8	3
Sludge (All Others)	Vitrification at Rocky Flats	3	4.2	1
Sludge (All Others)	Blend Down at Rocky Flats	3	4.2	1
Sludge (All Others)	Acid Dissolution at Rocky Flats	24	5.8	14
Sludge (All Others)	Filter/Dry at Rocky Flats (Alternative 4)	5	5.8	3
Glass	Neutralize/Dry at Rocky Flats	1	5.8	0
Glass	Vitrification at Rocky Flats	0	4.2	0
Glass	Blend Down at Rocky Flats	1	4.2	0
Glass	Sonic Wash at Rocky Flats	1	5.8	1
Glass	Mediated Electrochemical Oxidation at Rocky Flats	1	5.8	0
Glass	Neutralize/Dry (Alternative 4)	1	5.8	0
Graphite	Repackage at Rocky Flats	9	1.1	1
Graphite	Cement at Rocky Flats	20	1.1	2
Graphite	Vitrification at Rocky Flats	9	4.2	4
Graphite	Blend Down at Rocky Flats	9	4.2	4

Material	*Process*	*Exposure Years*	*Multiplier*	*Labor Costs*
Graphite	Mediated Electrochemical Oxidation at Rocky Flats	14	5.8	8
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	8	1.1	1
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	8	1.1	1
Graphite	Repackage at Rocky Flats (Alternative 4)	9	1.1	1
Inorganics	Repackage at Rocky Flats	2	1.1	0
Inorganics	Vitrification at Rocky Flats	2	4.2	1
Inorganics	Blend Down at Rocky Flats	2	4.2	1
Inorganics	Mediated Electrochemical Oxidation at Rocky Flats	3	5.8	2
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	1	1.1	0
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	1	1.1	0
Inorganics	Repackage at Rocky Flats (Alternative 4)	2	1.1	0
Scrub Alloy	Repackage at Rocky Flats	3	1.1	0
Scrub Alloy	Calcine and Vitrification at Rocky Flats	99	4.2	41
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	4	1.1	0
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	4	1.1	0

MSE/ER = molten salt extraction/electrorefining DOR = direct oxide reduction HEPA = high-efficiency particulate air

Table G–4 Exposure-Years, Person-Year Multiplier, Allocable Labor Costs (Dollars in Millions) at Savannah River Site

Material	*Process*	*Exposure Years*	*Multiplier*	*Labor Costs*
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site F-Canyon	227.1	5.8	132
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site H-Canyon	652.3	5.8	378
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	126.3	5.8	73
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	120.3	5.8	70
Sand, Slag, & Crucible	Repackage and Purex process at the Savannah River Site F-Canyon	31.7	5.8	18
Sand, Slag, & Crucible	Repackage and Purex process at the Savannah River Site H-Canyon	89.8	5.8	52
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	8.1	5.8	5
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	7.7	5.8	4

Material	*Process*	*Exposure Years*	*Multiplier*	*Labor Costs*
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	8.0	5.8	5
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	10.9	5.8	6
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	60.7	5.8	35
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	83.0	5.8	48
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	3.9	5.8	2
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	5.4	5.8	3
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	7.8	5.8	5
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	10.7	5.8	6
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	18.7	5.8	11
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	53.7	5.8	31
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	23.1	5.8	13
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	20.9	5.8	12
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	4.8	5.8	3
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	4.5	5.8	3
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	18.4	5.8	11
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	25.3	5.8	15

MSE/ER = molten salt extraction/electrorefining DOR = direct oxide reduction

As a practical matter, the only processing options for which the differences in *incremental* labor costs to DOE are likely to be significant are those with much higher exposure-years than the others. For example, Table G-3 shows that the duration of exposures at Rocky Flats to calcine and cement incinerator ash is more than double that to vitrify ash. This difference is outside the range of uncertainty in the processing technologies and the cost estimating approaches. On the other hand, exposure durations for vitrifying ash and fusing ash (for shipment to the Savannah River Site) differ by about 10 percent. This difference is within the range of uncertainty in the processing technologies. Costs, however, are shown as differing by a factor of four since vitrification has a labor multiplier of 4.2 and fusion and packaging has a multiplier of 1.1. Actual costs are unlikely to differ to this degree.

Three important caveats attach to the exposure multipliers. First, they are based on a very small sample. Four processes provide four very different multipliers that are then applied to more than 100 processing options. Increasing the sampling basis would certainly add to the set of multipliers. Second, the multipliers are applied to broadly similar processes without any adjustments. Detailed option-specific cost estimation (which will be conducted once the management alternative has been selected and schedules have been established) would

obviously increase the accuracy of the estimates. Third, regardless of the true (but unknown) multiplier for a single processing option, detailed costing and scheduling for a complete management alternative will force the multipliers towards a narrower range than 1.1 to 5.8. This narrower range will arise because of the relative fixity of many indirect and support costs; e.g., security and site administration. This is particularly true at the Savannah River Site, where all of the individual options are assigned a 5.8 labor multiplier based on their similarity to high-multiplier processing options at Rocky Flats, rather than direct or indirect costs at the Savannah River Site. Each of these three factors suggests that greater weight should be given to exposure-hours as a decision factor than to the implied labor costs. For example, the estimated decisional cost of the Preferred Alternative is about 40 percent higher than the Minimum Cost Management Approach ($334 million to $238 million) but exposures are only about 30 percent higher (306 exposure-years to 235 exposure-years). This suggests that the actual difference in the cost of the Preferred Alternative and the Minimum Cost Management Approach is likely to be smaller than implied by the multiplied labor costs.

G.1.3 Transuranic Waste Costs

Transuranic waste costs are estimated on a unit cost basis, as shown on **Table G–5. Table G–6** shows the total cost for acquiring the drums, characterizing the waste, shipping the waste drums to WIPP, disposing of the drums at WIPP, and so forth, by site, in millions of dollars.

Table G–5 Transuranic Waste—Cost Factors

Cost Factor	*Description*	*Value*	*References*
Transuranic Drum		$150/drum	1
Transuranic Pipe	TRUPACT-II pipe (2,800 fissile gram equivalent)	$2,000/drum	4
Interim Storage at Rocky Flats (drums certified for disposal at WIPP)	Transuranic drums prior to the WIPP shipping	$100/drum/yr for 3 years	3,2
Transuranic Shipping	14 drums per TRUPACT-II 3 TRUPACT-IIs per shipment		1
Shipping Cost - Rocky Flats to WIPP	1408 miles round-trip at $4,630 plus $10.87 per mile for each shipment	$475/drum for a 42-drum shipment	1
Shipping Cost - Los Alamos National Laboratory to WIPP	343 miles round-trip at $4,630 plus $10.87 per mile for each shipment	$199/drum for a 42-drum shipment	1
Shipping Cost - Savannah River Site to WIPP	3170 miles round-trip at $4,630 plus $10.87 per mile for each shipment	$931/drum for a 42-drum shipment	1
Transuranic Characterization Cost for WIPP	• Headspace gas sampling and analysis ($1,200/drum) • Real-time radiography and radioassay ($2,500/drum) • Data reporting and project management ($1,000/drum) • Resource Conservation and Recovery Act characterization ($1,000/drum) • Visual examination and inner bag gas sampling ($1,000/drum)	$6,700/drum	3
Variable Cost for Transuranic Disposal at WIPP	$5,500 per shipment	$131/drum for a 42-drum, 3-TRUPACT-II shipment	5

References:
1. DOE 1996c.
2. SAIC 1997c.
3. DOE 1996a.
4. DOE 1997a.

5. DOE 1996d (for *Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, Revision 5, DOE Carlsbad Area Office, April 1996.)

In the No-Action Alternative, transuranic waste and stabilized residues are created during the stabilization activities. The transuranic waste is packaged, characterized, and shipped as in the other alternatives. The stabilized residues will be retained at Rocky Flats for an indeterminate period of time (assumed for cost purposes to be 2015) before being shipped off-site. As a practical matter, the stabilized residues must ultimately be shipped somewhere and must ultimately be characterized to some disposal standard. For cost estimation, DOE estimates the costs for disposition of the stabilized residues to be the sum of the costs for interim on-site storage at Rocky Flats and the costs for packaging, characterization, transportation, and disposal at WIPP. Section G.1.6 summarizes the costs for interim on-site storage at Rocky Flats.

Table G–6 Transuranic Waste Packaging, Characterizing, Shipping, and Disposal Cost by Site (Dollars in Millions)

Material	*Process*	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*Cost*
Incinerator Ash	Calcine & Cement at Rocky Flats at Rocky Flats	51.3	0.0	0.0	0.7	52.0
Incinerator Ash	Vitrification at Rocky Flats	50.2	0.0	0.0	0.7	51.0
Incinerator Ash	Cold Ceramification at Rocky Flats	49.8	0.0	0.0	0.7	50.5
Incinerator Ash	Blend Down at Rocky Flats	59.7	0.0	0.0	0.8	60.6
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site F-Canyon	4.4	1.2	0.0	0.1	5.7
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site H-Canyon	4.4	1.2	0.0	0.1	5.7
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	4.4	2.0	0.0	0.1	6.6
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	4.4	2.0	0.0	0.1	6.6
Incinerator Ash	Calcine & Cement at Rocky Flats (Alternative 4)	51.3	0.0	0.0	0.7	52.0
Incinerator Ash	Repackage at Rocky Flats (Alternative 4)	51.7	0.0	0.0	0.7	52.4
Sand, Slag, & Crucible	Calcine & Cement at Rocky Flats	11.1	0.0	0.0	0.2	11.3
Sand, Slag, & Crucible	Vitrification at Rocky Flats	10.9	0.0	0.0	0.2	11.0
Sand, Slag, & Crucible	Blend Down at Rocky Flats	13.0	0.0	0.0	0.2	13.1
Sand, Slag, & Crucible	Repackage and Purex process at the Savannah River Site F-Canyon	0.9	0.1	0.0	0.0	1.0
Sand, Slag, & Crucible	Repackage and Purex process at the Savannah River Site H-Canyon	0.9	0.1	0.0	0.0	1.0
Sand, Slag, & Crucible	Calcine & Cement at Rocky Flats (Alternative 4)	4.0	0.0	0.0	0.0	4.0
Sand, Slag, & Crucible	Repackage at Rocky Flats (Alternative 4)	9.4	0.0	0.0	0.1	9.5
Graphite Fines	Cement at Rocky Flats	3.3	0.0	0.0	0.0	3.4
Graphite Fines	Vitrification at Rocky Flats	3.2	0.0	0.0	0.0	3.3
Graphite Fines	Blend Down at Rocky Flats	3.8	0.0	0.0	0.1	3.9
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	0.3	0.1	0.0	0.0	0.4
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	0.3	0.1	0.0	0.0	0.4
Graphite Fines	Cement at Rocky Flats (Alternative 4)	3.3	0.0	0.0	0.0	3.4
Graphite Fines	Repackage at Rocky Flats (Alternative 4)	3.3	0.0	0.0	0.0	3.4
Inorganic Ash	Calcine & Cement at Rocky Flats	7.4	0.0	0.0	0.1	7.5
Inorganic Ash	Vitrification at Rocky Flats	7.2	0.0	0.0	0.1	7.3

Material	*Process*	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*Cost*
Inorganic Ash	Blend Down at Rocky Flats	8.6	0.0	0.0	0.1	8.7
Inorganic Ash	Calcine & Cement at Rocky Flats (Alternative 4)	7.4	0.0	0.0	0.1	7.5
Inorganic Ash	Repackage at Rocky Flats (Alternative 4)	7.4	0.0	0.0	0.1	7.6
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats	14.0	0.0	0.0	0.2	14.2
MSE/ER Salts (IDC 409)	Blend Down at Rocky Flats	13.5	0.0	0.0	0.2	13.7
MSE/ER Salts (IDC 409)	Distillation at Rocky Flats	0.7	0.0	0.0	0.0	0.7
MSE/ER Salts (IDC 409)	Water Leach at Rocky Flats	12.0	0.0	0.0	0.2	12.2
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats and distillation at Los Alamos National Laboratory	0.7	0.0	0.6	0.0	1.3
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	1.3	0.1	0.0	0.0	1.5
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	1.3	0.1	0.0	0.0	1.5
MSE/ER Salts (IDC 409)	Pyro-oxidize, Blend, Repackage (Alternative 4)	11.2	0.0	0.0	0.2	11.4
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats	39.5	0.0	0.0	0.6	40.0
MSE/ER Salts (All Others)	Blend Down at Rocky Flats	101.4	0.0	0.0	1.4	102.8
MSE/ER Salts (All Others)	Distillation at Rocky Flats	3.9	0.0	0.0	0.1	3.9
MSE/ER Salts (All Others)	Water Leach at Rocky Flats	89.3	0.0	0.0	1.6	90.8
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats and distillation at Los Alamos National Laboratory	3.5	0.0	3.4	0.1	7.0
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	8.6	0.7	0.0	0.2	9.4
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	8.6	0.7	0.0	0.2	9.4
MSE/ER Salts (All Others)	Pyro-oxidize (Alternative 4)	39.5	0.0	0.0	0.6	40.0
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats	5.8	0.0	0.0	0.1	5.9
DOR Salts (IDCs 365, 413, 427)	Blend Down at Rocky Flats	6.6	0.0	0.0	0.1	6.7
DOR Salts (IDCs 365, 413, 427)	Water Leach at Rocky Flats	5.9	0.0	0.0	0.1	6.0

Material	*Process*	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*Cost*
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	0.3	0.0	5.9	0.1	6.4
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	0.3	0.0	5.8	0.1	6.2
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	0.6	0.0	0.0	0.0	0.7
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	0.6	0.0	0.0	0.0	0.7
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize, Blend, Repackage (Alternative 4)	8.1	0.0	0.0	0.1	8.2
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats	3.3	0.0	0.0	0.0	3.4
DOR Salts (All Others)	Blend Down at Rocky Flats	13.0	0.0	0.0	0.2	13.2
DOR Salts (All Others)	Water Leach at Rocky Flats	11.6	0.0	0.0	0.2	11.8
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	0.4	0.0	11.4	0.2	12.0
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	0.4	0.0	11.2	0.2	11.8
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	1.1	0.1	0.0	0.0	1.2
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	1.1	0.1	0.0	0.0	1.2
DOR Salts (All Others)	Pyro-oxidize (Alternative 4)	3.3	0.0	0.0	0.0	3.4
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats	3.3	0.0	0.0	0.1	3.4
Aqueous-Contaminated Combustibles	Sonic Wash at Rocky Flats	1.7	0.0	0.0	0.0	1.7
Aqueous-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	4.3	0.0	0.0	0.1	4.4
Aqueous-Contaminated Combustibles	Blend Down at Rocky Flats	0.8	0.0	0.0	0.0	0.8
Aqueous-Contaminated Combustibles	Mediated Electrochemical Oxidation	4.0	0.0	0.0	0.1	4.1
Aqueous-Contaminated Combustibles	Neutralize/Dry (Alternative 4)	3.3	0.0	0.0	0.1	3.4
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats	2.3	0.0	0.0	0.0	2.4
Organic-Contaminated Combustibles	Sonic Wash at Rocky Flats	1.2	0.0	0.0	0.0	1.2
Organic-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	3.0	0.0	0.0	0.1	3.1

Material	*Process*	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*Cost*
Organic-Contaminated Combustibles	Blend Down at Rocky Flats	0.6	0.0	0.0	0.0	0.6
Organic-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	2.8	0.0	0.0	0.0	2.9
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation (Alternative 4)	2.3	0.0	0.0	0.0	2.4
Dry Combustibles	Repackage at Rocky Flats	1.9	0.0	0.0	0.0	1.9
Dry Combustibles	Sonic Wash at Rocky Flats	1.0	0.0	0.0	0.0	1.0
Dry Combustibles	Catalytic Chemical Oxidation at Rocky Flats	2.4	0.0	0.0	0.0	2.5
Dry Combustibles	Blend Down at Rocky Flats	0.5	0.0	0.0	0.0	0.5
Dry Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	2.3	0.0	0.0	0.0	2.3
Dry Combustibles	Repackage at Rocky Flats (Alternative 4)	1.9	0.0	0.0	0.0	1.9
Plutonium Fluorides	Acid Dissolution at Rocky Flats	3.5	0.0	0.0	0.1	3.6
Plutonium Fluorides	Blend Down at Rocky Flats	37.1	0.0	0.0	0.5	37.6
Plutonium Fluorides	Acid Dissolution at Rocky Flats	2.5	0.0	0.0	0.0	2.5
Plutonium Fluorides	Repackage at Rocky Flats and Purex process at the Savannah River Site F-Canyon	0.2	0.1	0.0	0.0	0.3
Plutonium Fluorides	Repackage at Rocky Flats and Purex process at the Savannah River Site H-Canyon	0.2	0.1	0.0	0.0	0.3
Ful Flo Filter Media	Neutralize/Dry at Rocky Flats	11.8	0.0	0.0	0.2	12.0
Ful Flo Filter Media	Blend Down at Rocky Flats	2.4	0.0	0.0	0.0	2.5
Ful Flo Filter Media	Sonic Wash at Rocky Flats	3.1	0.0	0.0	0.0	3.2
Ful Flo Filter Media	Mediated Electrochemical Oxidation at Rocky Flats	6.4	0.0	0.0	0.1	6.5
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats	25.1	0.0	0.0	0.4	25.6
HEPA Filters (IDC 338)	Vitrification at Rocky Flats	5.9	0.0	0.0	0.1	6.0
HEPA Filters (IDC 338)	Blend Down at Rocky Flats	5.1	0.0	0.0	0.1	5.2
HEPA Filters (IDC 338)	Sonic Wash at Rocky Flats	6.6	0.0	0.0	0.1	6.7
HEPA Filters (IDC 338)	Mediated Electrochemical Oxidation at Rocky Flats	13.7	0.0	0.0	0.2	13.9
HEPA Filters (IDC 338)	Neutralize/Dry (Alternative 4)	25.1	0.0	0.0	0.4	25.6
HEPA Filters (All Others)	Neutralize/Dry at Rocky Flats	0.8	0.0	0.0	0.0	0.8
HEPA Filters (All Others)	Vitrification at Rocky Flats	0.4	0.0	0.0	0.0	0.4
HEPA Filters (All Others)	Blend Down at Rocky Flats	0.4	0.0	0.0	0.0	0.4

Material	*Process*	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*Cost*
HEPA Filters (All Others)	Sonic Wash at Rocky Flats	0.5	0.0	0.0	0.0	0.5
HEPA Filters (All Others)	Mediated Electrochemical Oxidation at Rocky Flats	1.0	0.0	0.0	0.0	1.0
HEPA Filters (All Others)	Blend and Re-repackage (Alternative 4)	0.7	0.0	0.0	0.0	0.7
Sludge (IDCs 089, 099, 332)	Filter/Dry at Rocky Flats	0.4	0.0	0.0	0.0	0.4
Sludge (IDCs 089, 099, 332)	Vitrification at Rocky Flats	0.0	0.0	0.0	0.0	0.0
Sludge (IDCs 089, 099, 332)	Blend Down at Rocky Flats	0.1	0.0	0.0	0.0	0.1
Sludge (IDCs 089, 099, 332)	Blend and Re-repackage (Alternative 4)	0.1	0.0	0.0	0.0	0.1
Sludge (All Others)	Filter/Dry at Rocky Flats	8.6	0.0	0.0	0.2	8.8
Sludge (All Others)	Vitrification at Rocky Flats	1.9	0.0	0.0	0.0	2.0
Sludge (All Others)	Blend Down at Rocky Flats	1.9	0.0	0.0	0.0	1.9
Sludge (All Others)	Acid Dissolution at Rocky Flats	4.9	0.0	0.0	0.1	5.0
Sludge (All Others)	Filter/Dry (Alternative 4)	8.6	0.0	0.0	0.2	8.8
Glass	Neutralize/Dry at Rocky Flats	0.1	0.0	0.0	0.0	0.2
Glass	Vitrification at Rocky Flats	0.4	0.0	0.0	0.0	0.4
Glass	Blend Down at Rocky Flats	0.4	0.0	0.0	0.0	0.4
Glass	Sonic Wash at Rocky Flats	0.4	0.0	0.0	0.0	0.4
Glass	Mediated Electrochemical Oxidation at Rocky Flats	1.1	0.0	0.0	0.0	1.1
Glass	Neutralize/Dry (Alternative 4)	0.1	0.0	0.0	0.0	0.2
Graphite	Repackage at Rocky Flats	6.7	0.0	0.0	0.1	6.8
Graphite	Cement at Rocky Flats	6.8	0.0	0.0	0.1	6.9
Graphite	Vitrification at Rocky Flats	6.0	0.0	0.0	0.1	6.1
Graphite	Blend Down at Rocky Flats	6.0	0.0	0.0	0.1	6.1
Graphite	Mediated Electrochemical Oxidation at Rocky Flats	15.4	0.0	0.0	0.3	15.6
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	0.6	0.3	0.0	0.0	0.9
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	0.6	0.3	0.0	0.0	0.9
Graphite	Repackage at Rocky Flats (Alternative 4)	6.7	0.0	0.0	0.1	6.8
Inorganics	Repackage at Rocky Flats	1.3	0.0	0.0	0.0	1.3
Inorganics	Vitrification at Rocky Flats	1.1	0.0	0.0	0.0	1.1
Inorganics	Blend Down at Rocky Flats	1.1	0.0	0.0	0.0	1.1
Inorganics	Mediated Electrochemical Oxidation at Rocky Flats	3.6	0.0	0.0	0.1	3.7

Material	*Process*	*Rocky Flats*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*Cost*
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	0.1	0.1	0.0	0.0	0.2
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	0.1	0.1	0.0	0.0	0.2
Inorganics	Repackage at Rocky Flats (Alternative 4)	1.3	0.0	0.0	0.0	1.3
Scrub Alloy	Repackage at Rocky Flats	2.5	0.0	0.0	0.0	2.5
Scrub Alloy	Calcine and Vitrification at Rocky Flats	26.5	0.0	0.0	0.4	26.9
Scrub Alloy	Repackage at Rocky Flats and Purex process at the Savannah River Site F-Canyon	0.3	0.2	0.0	0.0	0.5
Scrub Alloy	Repackage at Rocky Flats and Purex process at the Savannah River Site H-Canyon	0.3	0.2	0.0	0.0	0.5

MSE/ER = molten salt extraction/electrorefining DOR = direct oxide reduction HEPA = high-efficiency particulate air

Transuranic waste drums are shipped in TRUPACT-II containers. DOE assumes that drums of processed or repackaged residues from Rocky Flats are packed at the maximum allowable level of 14 per TRUPACT-II and three TRUPACT-II's per truck (42 drums per truck). This assumption is possible because the waste mass in the drums is limited by plutonium content rather than total mass. The plutonium limitation results in very light drums and thus does not approach weight limits per drum, TRUPACT-II, or truck.

The major cost components of preparing for disposal at WIPP are about $6,700 per drum for characterization of the transuranic waste and about $2,000 per drum for the pipe component[1] Shipping costs for a 42-drum shipment are estimated at $199 per drum from the Los Alamos National Laboratory, $435 per drum from Rocky Flats, and $931 per drum from the Savannah Rive Site. Disposal at WIPP is based on the *incremental* cost of disposal. Based on a disposal cost per shipment (regardless of drum count) of $5,500 and the maximum 42 drums per shipment, the variable cost of disposal at WIPP is about $131 per drum. For the preferred alternative and all of the other plausible management approaches, this unit cost implies a total variable cost at WIPP of $1 to $3 million. Fixed costs at WIPP (which are roughly $7,000 per drum) are not decisional in the present EIS since they have already been charged to the overall WIPP program and cannot be affected by the number of drums shipped pursuant to the Record of Decision in the present EIS.

G.1.4 Low-Level Waste Costs

Low-level waste costs and cost factors for Rocky Flats and the Los Alamos National Laboratory are estimated on a unit cost basis, as shown on **Table G–7**. The total cost of shipping and disposal is just over $1,050 per drum. Low-level waste characterization, shipping, and disposal costs exceed $2 million in seven processing options at Rocky Flats and two at the Los Alamos National Laboratory. The seven at Rocky Flats are calcine and cementation of incinerator ash ($3 million), distillation of IDC 409 electrorefining and molten salt extraction salts ($4 million), water leach of other direct oxide reduction salts ($4 million), water leach of other

[1]*Not all drums of transuranic waste require or allow a pipe component. See the products and wastes tables in Chapter 4 regarding drum counts and pipe components for each processing option.*

electrorefining and molten salt extraction salts ($29 million), and mediated electrochemical oxidation of Ful Flo filters ($2 million), other high-efficiency particulate air filters ($4 million), and graphite. ($5 million). At the Los Alamos National Laboratory, water leach and acid dissolution of other direct oxide reduction salts each generate about $4 million in low-level waste-related costs. No activity at the Savannah River Site generates economically significant quantities of low-level waste.

Table G–7 Low-Level Waste Costs and Cost Factors (Rocky Flats and the Los Alamos National Laboratory)

Cost Factor	*Description*	*Cost*	*Reference*
Drum		$150/drum	1
Interim Storage at Rocky Flats		$50/year for 1 year	2
Characterization	Real-time radiography and radioassay ($133/drum) NDA ($116/drum) Data reporting, movement and management ($439/drum)	$688/drum	3
Shipping		$30/drum	4
Disposal		$150/drum	5

References:
1. Same drum as for transuranic waste.
2. SAIC estimate.
3. SAIC 1997c.
4. SAIC 1997b.
5. DOE 1996a.

G.1.5 Other Materials, Storage, Shipping, and Disposal Costs

Processing wastes generated at the Savannah River Site are disposed as low-level waste at the Savannah River Site, intermediate-level waste as saltstone at the Savannah River Site, transuranic waste at WIPP, and high-level waste as vitrified glass logs (Defense Waste Processing Facility logs) at the future monitored geologic repository. **Table G–8** shows unit costs for these wastes, excluding transuranic waste, which was shown on Table G-5. The combined costs to dispose of low-level and intermediate-level wastes from any alternative at the Savannah River Site is less than $1 million. Total costs related to transuranic waste disposal exceed $2 million only for mediated electrochemical oxidation of incinerator ash ($2 million). The costs to manufacture and dispose of Defense Waste Processing Facility logs exceed $2 million for mediated electrochemical oxidation of incinerator ash ($52 million), graphite fines ($4 million), and graphite ($16 million); and Purex processing of fused incinerator ash ($8 million) and sand, slag, and crucible ($8 million). Costs for disposing of wastes generated at H-Canyon or F-Canyon are about the same. In the case of mediated electrochemical oxidation at the Savannah River Site H-Canyon, decontamination and decommissioning of contaminated equipment at HB-Line would generate 1,800 cubic feet (about 250 drums) of transuranic waste, 2,000 cubic feet of low-level waste, and 20 cubic feet of mixed transuranic waste. Disposal costs for this amount of waste would be about $2 million.

Certain processing options at Rocky Flats or Los Alamos National Laboratory separate americium or plutonium that must be stored onsite for some period of time before shipment in 3013 containers and Safe, Secure Trailers. Costs for these functions are estimated in Table G–8. Plutonium storage costs are based on a long-run average of $3,500/position/year in the Savannah River Site's modified 235F or FB-Line vaults and $1,000/position/year in the New Plutonium Storage Vault, scheduled to start in May, 2002. Each 3013 container is assumed to contain 4 kg (8.8 lbs) of refined plutonium. A Safe, Secure Trailer is assumed to carry twenty-four 3013 containers. In practice, the amount of refined plutonium in a 3013 container may be more or less than 4 kg (8.8 lbs) (up to 4.99 kg [11 lbs] in some cases), depending on the batch size of the processes. The cost impact of batches in the 2- to 4-kg (4.4- to 8.8-lb) range is small. The cost impact of increasing the Safe, Secure Trailer loading to the maximum of thirty 3013 containers is also insignificant. At 4 kg (8.8 lbs), the cost of 3013 storage is in the $2 million range only for distillation or water leach of other electrorefining or molten salt extraction salts at Rocky Flats or incinerator ash processing (Purex or mediated electrochemical

oxidation) at the Savannah River Site. The higher costs at Rocky Flats for the smaller quantity of plutonium is due to the post-storage shipping costs from Rocky Flats to the Savannah River Site for ultimate disposition. The cost for disposition is based on DOE's current life-cycle cost estimate of $1.83 billion (undiscounted 1996 dollars) to dispose of 50 metric tons of plutonium.

Table G–8 Other Storage and Shipping Costs

Cost Factor	*Description*	*Cost*	*Reference*
3013 Container Storage	Facility cost	$1,500/container/year for 5 years	2
3013 Container Transfer	To secure storage	$3,000/container	1
Safe, Secure Trailer Shipping	Rocky Flats to Los Alamos National Laboratory	$18,000/Safe Secure Trailer	1
	Rocky Flats to the Savannah River Site	$66,800/Safe Secure Trailer	1
Low-Level Waste at the Savannah River Site	Onsite storage	$2.50/cubic feet	1
Low-Level Waste Saltstone at the Savannah River Site	Onsite storage	$675/cubic yard	1
High-Level Waste Glass	Defense Waste Processing Facility and Repository	$2M/log	1
Fissile Materials Disposition	Can-in-canister immobilization	$36,600/kilogram	3

References:
1. DOE 1996a.
2. Assuming 5 years' storage prior to acceptance by the fissile materials disposition program.
3. DOE 1996b.

G.1.6 Costs Related to Interim Storage of Stabilized Residues and Transuranic Waste at Rocky Flats

DOE estimates that if any of the No Action processing options were selected, stabilized residues that could not be shipped to WIPP would have to be stored on-site on an interim basis. The cost to store stabilized residues at an otherwise shutdown site would be $23 million per year. These residues would be stored in Building 371. Activities under other EISs at Rocky Flats (e.g., plutonium solutions, highly enriched uranium) and at other sites (e.g., WIPP, the Savannah River Site, and Los Alamos National Laboratory) are assumed to not affect the Rocky Flats closure schedule. Similarly, activities in this EIS that would accelerate the removal of particular residues from particular facilities compared to the baseline shutdown years (2003 for Building 707, and 2006 for Building 371) are excluded (DOE 1997b). The EIS allocates storage costs for twenty years, starting when DOE is assumed to have closed the site (about 2006 with accelerated shipment of all materials off site). The year 2006 is also about the time when processing under the No Action Alternative would be completed. The longest duration operations under the No Action Alternative take place at Building 371, Room 3701. They require an estimated 7.2 years of processing. The residues in the present EIS are not on the critical path for site closure if shipment to WIPP under Alternative 4 is selected for the bulk of the ash and salt residues. The Preferred Alternative includes such shipments.

Under the assumption that the stabilized residues stored at Rocky Flats will ultimately have to be disposed somewhere, this EIS develops cost estimates as if the residues were disposed at WIPP in 2025. The undiscounted cost for interim storage over 20 years is estimated at $460 million ($23 million per year for 20 years).

G.2 PROCESSING DURATIONS AND SCHEDULES

The following facilities at Rocky Flats are candidates for use under this EIS: Building 707, Modules A, B, D, E, F, and J; and Building 371, Rooms 3701 and 3305. The only facilities that could be on the critical path for Rocky Flats' closure are Modules A and E at Building 707 and Room 3701 at Building 371. **Table G–9** shows the longest duration processing options individually for the activities at Building 707, Modules A and E, and Building 371, Room 3701. For each processing option, the value on Table G–9 is the duration (in years) of the longest phase of the processing options at the specified facility. At Rocky Flats (and the Los Alamos National Laboratory), the duration of the processing is based on plutonium concentrations and plutonium mass.[2] All phases include estimated down-time for maintenance, facility availability, unscheduled down-time, and so forth. **Table G–10** shows the duration of the longest phase of each processing option (in weeks), regardless of facility.

Table G–9 Long-Duration Activities, Years for Longest Phase at Critical Path Facilities

Processing option	*Building 707, Module A*	*Building 707, Module E*	*Building 371, Room 3701*
Blend other electrorefining and molten salt extraction salts at Rocky Flats	6.7	6.3	
Blend IDC 409 electrorefining and molten salt extraction salts at Rocky Flats	2.8	2.6	
Pyro-oxidize other electrorefining and molten salt extraction salts at Rocky Flats under Alternative 4	2.4	2.3	
Pyro-oxidize other electrorefining and molten salt extraction salts at Rocky Flats for shipment to the Los Alamos National Laboratory	1.6		1.6
Blend IDC 365, 413, 427 direct oxide reduction salts at Rocky Flats	1.6	1.5	
Blend incinerator ash at Rocky Flats		2.5	
Calcine and vitrify scrub alloy at Rocky Flats		2.2	
Furnace vitrify incinerator ash at Rocky Flats		2.2	
Blend plutonium fluorides at Rocky Flats		1.6	
Calcine and cement incinerator ash at Rocky Flats			3.0
Water leach other electrorefining and molten salt extraction salts at Rocky Flats			1.5
Neutralize/dry IDC 338 filter media at Rocky Flats			1.1

Table G–10 Duration of Longest Phase at Primary and Secondary Facility, by Material (Same Phase, Potential Critical Path Secondary Facilities Only)

Material	*Process*	*Duration (Weeks)*	*Primary Facility*	*Duration (Weeks)*	*Secondary Facility*
Incinerator Ash	Calcine & Cement at Rocky Flats	155.7	3701	0	0
Incinerator Ash	Vitrification at Rocky Flats	113.5	707	0	0
Incinerator Ash	Cold Ceramification at Rocky Flats	68.1	707	0	0
Incinerator Ash	Blend Down at Rocky Flats	129.7	707	0	0
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site F-Canyon	78.1	707	0	0
Incinerator Ash	Fusion at Rocky Flats and Purex process at the Savannah River Site H-Canyon	78.1	707	0	0

[2]*Processing time at the Savannah River Site is a function of total residue mass.*

Material	*Process*	*Duration (Weeks)*	*Primary Facility*	*Duration (Weeks)*	*Secondary Facility*
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	56.2	707	0	0
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	56.2	707	0	0
Incinerator Ash	Calcine & Cement at Rocky Flats (Alternative 4)	155.7	3701	0	0
Incinerator Ash	Repackage at Rocky Flats (Alternative 4)	55.8	707	0	0
Sand, Slag, & Crucible	Calcine & Cement at Rocky Flats	22.1	3701	0	0
Sand, Slag, & Crucible	Vitrification at Rocky Flats	16.1	707	0	0
Sand, Slag, & Crucible	Blend Down at Rocky Flats	18.4	707	0	0
Sand, Slag, & Crucible	Repackage and Purex process at the Savannah River Site F-Canyon	16.8	707	0	0
Sand, Slag, & Crucible	Repackage and Purex process at the Savannah River Site H-Canyon	16.8	707	0	0
Sand, Slag, & Crucible	Calcine & Cement at Rocky Flats (Alternative 4)	25.8	3701	0	0
Sand, Slag, & Crucible	Repackage at Rocky Flats (Alternative 4)	8.0	707	0	0
Graphite Fines	Cement at Rocky Flats	12.7	3701	0	0
Graphite Fines	Vitrification at Rocky Flats	9.2	707	0	0
Graphite Fines	Blend Down at Rocky Flats	10.6	707	0	0
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	4.6	707	0	0
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	4.6	707	0	0
Graphite Fines	Cement at Rocky Flats (Alternative 4)	12.7	3701	0	0
Graphite Fines	Repackage at Rocky Flats (Alternative 4)	4.5	707	0	0
Inorganic Ash	Calcine & Cement at Rocky Flats	8.7	3701	0	0
Inorganic Ash	Vitrification at Rocky Flats	6.4	707	0	0
Inorganic Ash	Blend Down at Rocky Flats	7.3	707	0	0
Inorganic Ash	Calcine & Cement at Rocky Flats (Alternative 4)	8.7	3701	0	0
Inorganic Ash	Repackage at Rocky Flats (Alternative 4)	3.1	707	0	0
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats	52.2	707A	49	707
MSE/ER Salts (IDC 409)	Blend Down at Rocky Flats	143.6	707A	135	707
MSE/ER Salts (IDC 409)	Distillation at Rocky Flats	33.4	707A	0	0
MSE/ER Salts (IDC 409)	Water Leach at Rocky Flats	32.5	3701	0	0
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats and distillation at Los Alamos National Laboratory	34.8	707A	34	707D
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	19.6	707A	0	0

Material	*Process*	*Duration (Weeks)*	*Primary Facility*	*Duration (Weeks)*	*Secondary Facility*
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	19.6	707A	0	0
MSE/ER Salts (IDC 409)	Pyro-oxidize, Blend, Repackage (Alternative 4)	14.7	707A	15	707
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats	126.6	707A	119	707
MSE/ER Salts (All Others)	Blend Down at Rocky Flats	348.5	707A	328	707
MSE/ER Salts (All Others)	Distillation at Rocky Flats	81.1	707A	0	0
MSE/ER Salts (All Others)	Water Leach at Rocky Flats	78.9	3701	0	0
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats and distillation at Los Alamos National Laboratory	84.4	707A	81	707D
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	47.5	707A	0	0
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	47.5	707A	0	0
MSE/ER Salts (All Others)	Pyro-oxidize (Alternative 4)	126.6	707A	119	707
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats	52.0	707A	52	707
DOR Salts (IDCs 365, 413, 427)	Blend Down at Rocky Flats	84.2	707A	79	707
DOR Salts (IDCs 365, 413, 427)	Water Leach at Rocky Flats	19.1	3701	0	0
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	6.8	707A	6	707D
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	6.8	707A	6	707D
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	11.5	707A	0	0
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	11.5	707A	0	0
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize Blend, Repackage (Alternative 4)	8.6	707A	9	707
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats	19.1	707A	19	707
DOR Salts (All Others)	Blend Down at Rocky Flats	30.9	707A	29	707
DOR Salts (All Others)	Water Leach at Rocky Flats	7.0	3701	0	0
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	2.5	707A	0	0
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	2.5	707A	0	0
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	4.2	707A	0	0
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	4.2	707A	0	0

Material	*Process*	*Duration (Weeks)*	*Primary Facility*	*Duration (Weeks)*	*Secondary Facility*
DOR Salts (All Others)	Pyro-oxidize (Alternative 4)	19.1	707A	19	707
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats	7.7	3701	0	0
Aqueous-Contaminated Combustibles	Sonic Wash at Rocky Flats	7.2	3701	0	0
Aqueous-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	24.5	3701	0	0
Aqueous-Contaminated Combustibles	Blend Down at Rocky Flats	1.3	3701	0	0
Aqueous-Contaminated Combustibles	Mediated Electrochemical Oxidation	17.6	3701	0	0
Aqueous-Contaminated Combustibles	Neutralize/Dry (Alternative 4)	7.7	3701	0	0
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats	20.2	3701	0	0
Organic-Contaminated Combustibles	Sonic Wash at Rocky Flats	5.1	3701	0	0
Organic-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	17.2	3701	0	0
Organic-Contaminated Combustibles	Blend Down at Rocky Flats	0.9	3701	0	0
Organic-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	12.3	3701	0	0
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation (Alternative 4)	20.2	3701	0	0
Dry Combustibles	Repackage at Rocky Flats	1.2	707D	0	0
Dry Combustibles	Sonic Wash at Rocky Flats	4.1	3701	0	0
Dry Combustibles	Catalytic Chemical Oxidation at Rocky Flats	14.1	3701	0	0
Dry Combustibles	Blend Down at Rocky Flats	0.8	3701	0	0
Dry Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	10.1	3701	0	0
Dry Combustibles	Repackage at Rocky Flats (Alternative 4)	1.2	707D	0	0
Plutonium Fluorides	Acid Dissolution at Rocky Flats	25.4	3701	0	0
Plutonium Fluorides	Blend Down at Rocky Flats	81.7	707	0	0
Plutonium Fluorides	Acid Dissolution at Rocky Flats	25.4	3701	0	0
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	9.0	3701	0	0
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	9.0	3701	0	0
Ful Flo Filter Media	Neutralize/Dry at Rocky Flats	12.4	3701	0	0
Ful Flo Filter Media	Blend Down at Rocky Flats	2.8	3701	0	0
Ful Flo Filter Media	Sonic Wash at Rocky Flats	11.3	3701	0	0
Ful Flo Filter Media	Mediated Electrochemical Oxidation at Rocky Flats	4.6	3701	0	0
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats	57.7	3701	0	0
HEPA Filters (IDC 338)	Vitrification at Rocky Flats	11.6	707	0	0
HEPA Filters (IDC 338)	Blend Down at Rocky Flats	13.0	3701	0	0

Material	*Process*	*Duration (Weeks)*	*Primary Facility*	*Duration (Weeks)*	*Secondary Facility*
HEPA Filters (IDC 338)	Sonic Wash at Rocky Flats	52.5	3701	0	0
HEPA Filters (IDC 338)	Mediated Electrochemical Oxidation at Rocky Flats	21.5	3701	0	0
HEPA Filters (IDC 338)	Neutralize/Dry (Alternative 4)	57.7	3701	0	0
HEPA Filters (All Others)	Neutralize/Dry at Rocky Flats	2.0	3701	0	0
HEPA Filters (All Others)	Vitrification at Rocky Flats	0.3	707	0	0
HEPA Filters (All Others)	Blend Down at Rocky Flats	1.0	3701	0	0
HEPA Filters (All Others)	Sonic Wash at Rocky Flats	1.2	3701	0	0
HEPA Filters (All Others)	Mediated Electrochemical Oxidation at Rocky Flats	0.5	3701	0	0
HEPA Filters (All Others)	Blend and Repackage at Rocky Flats (Alternative 4)	1.1	707	0	0
Sludge (IDCs 089, 099, 332)	Filter/Dry at Rocky Flats	0.5	707	0	0
Sludge (IDCs 089, 099, 332)	Vitrification at Rocky Flats	3.3	707	0	0
Sludge (IDCs 089, 099, 332)	Blend Down at Rocky Flats	1.7	707	0	0
Sludge (IDCs 089, 099, 332)	Blend and Repackage at Rocky Flats (Alternative 4)	0.8	707	0	0
Sludge (All Others)	Filter/Dry at Rocky Flats	10.4	707	0	0
Sludge (All Others)	Vitrification at Rocky Flats	3.3	707	0	0
Sludge (All Others)	Blend Down at Rocky Flats	3.2	707	0	0
Sludge (All Others)	Acid Dissolution at Rocky Flats	45.9	3701	0	0
Sludge (All Others)	Filter/Dry at Rocky Flats (Alternative 4)	10.4	3701	0	0
Glass	Neutralize/Dry at Rocky Flats	1.9	3701	0	0
Glass	Vitrification at Rocky Flats	0.6	707	0	0
Glass	Blend Down at Rocky Flats	0.7	3701	0	0
Glass	Sonic Wash at Rocky Flats	2.1	3701	0	0
Glass	Mediated Electrochemical Oxidation at Rocky Flats	1.2	3701	0	0
Glass	Neutralize/Dry (Alternative 4)	1.9	3701	0	0
Graphite	Repackage at Rocky Flats	12.2	707	0	0
Graphite	Cement at Rocky Flats	16.6	3701	0	0
Graphite	Vitrification at Rocky Flats	12.2	707	0	0
Graphite	Blend Down at Rocky Flats	12.2	707	0	0
Graphite	Mediated Electrochemical Oxidation at Rocky Flats	23.8	3701	0	0
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	22.3	3701	10	707
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	22.3	3701	10	707

Material	*Process*	*Duration (Weeks)*	*Primary Facility*	*Duration (Weeks)*	*Secondary Facility*
Graphite	Repackage at Rocky Flats (Alternative 4)	12.2	707	0	0
Inorganics	Repackage at Rocky Flats	2.2	707	0	0
Inorganics	Vitrification at Rocky Flats	2.2	707	0	0
Inorganics	Blend Down at Rocky Flats	2.2	707	0	0
Inorganics	Mediated Electrochemical Oxidation at Rocky Flats	3.5	3701	0	0
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	2.7	3701	0	0
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	2.7	3701	0	0
Inorganics	Repackage at Rocky Flats (Alternative 4)	2.2	707	0	0
Scrub Alloy	Repackage at Rocky Flats	5.7	707	0	0
Scrub Alloy	Calcine and Vitrification at Rocky Flats	115.1	707	0	0
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	6.3	3701	0	0
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	6.3	3701	0	0

MSE/ER = molten salt extraction/electrorefining DOR = direct oxide reduction HEPA = high-efficiency particulate air

Because all activities have multiple phases (e.g., unload, bag-in, feed preparation, treatment, nondestructive analysis, bag-out, load transport), the duration of a processing option at a facility is longer than that of the single longest phase. Also, because facilities will be down while the transition is made from one residue or processing option to the next, the duration of time associated with a series of processing options is longer than the sum of the individual processing options. Combining these two timing factors, DOE estimates that the actual time required for processing a residue is about 15 percent greater than the time for the single longest phase of the processing option. The 15 percent adder is an approximation for use in estimating the impacts from a series of processing options where multiple phases, batch sizes, facilities, and transitions are involved.

Note that the time required at Rocky Flats to complete a management alternative is processing time, not calendar-time from a fixed date. For example, pyro-oxidation of certain materials (which is required for stabilization on-site and is also required as a precursor to certain processing options) began in October, 1997. Use of this pyro-oxidized material could accelerate certain scenarios. On the other hand, qualification of sand, slag, and crucible for disposal at WIPP under Alternative 4 may require several months of additional characterization to ensure that reactivity and pyrophoricity limits are not exceeded.

Note also that the shortest total processing time at Rocky Flats is not necessarily the sum of the shortest individual processing options. **Table G-11** shows the durations of the eight strategic management approaches. The table shows that the critical path facility is Building 707, Module E in four cases, Building 707, Module A in two cases, and Building 371, Room 3701 in two cases. In each case, the total duration of processing at Rocky Flats can be reduced by shifting some activities out of the critical path facility and into one or more other facilities. For example, the minimum time at Rocky Flats can be reduced from an estimated 2.6 years to about 1.8 years by selecting processing options that optimize the integrated duration of activities across the site rather than the individual durations at each facility. None of the durations shown in this section include

technical or schedule uncertainties, deferred start-up due to technology demonstration and testing, or schedule interactions among processing options, facilities, or sites. Section G.3 discusses these issues.

Table G–11 Durations of Strategic Management Approaches

	No Action	*Preferred*	*Minimum Time at Rocky Flats*	*Lowest Cost*	*All at Rocky Flats*	*Fewest at Rocky Flats*	*Maximum Plutonium Separation*	*No Separation*
Years	**7.2**	**5.5**	**2.6**	**3.2**	**5.1**	**2.8**	**3.4**	**10.2**
Critical Path	371-3701	707E	707E	707A	707E	707A	371- 3701	707E

G.3 MAJOR SCHEDULE UNCERTAINTIES

Major schedule uncertainties are outlined below. Technical uncertainties were summarized in Section 4.17.4 and 4.17.7. For each category, the estimated time beyond the Record of Decision is provided. No schedule delays due to general facilities or equipment upgrades a re envisioned.

- *Acid Dissolution (Rocky Flats)*—Acid dissolution for processing plutonium fluorides or sludges is a proven process, but the capabilities for it are not currently available at Rocky Flats. Also, this process would take place in the same area of Building 371 as the neutralize/dry process for combustibles (including combustibles below Safeguard Termination Limits). Because the acid dissolution of fluorides or sludges would be required to follow all combustibles processing, it might not be able to start for 4 years.

- *Catalytic Chemical Oxidation*—Catalytic chemical oxidation has been demonstrated commercially but not as a production process at the scale or with the characteristics required for the plutonium residues. The time required to demonstrate a consistent process and develop procedures and supporting analyses is estimated at four years.

- *Cementation*—Rocky Flats would have to install or remodel gloveboxes to provide additional area for the curing stage. The time required to be fully operational is estimated at one year.

- *Cold Ceramification*—Cold ceramification is a relatively simple process (similar to cementation) but it is still in the development stage. Rocky Flats has proposed additional demonstrations of surrogate testing and actual residue testing to be performed in FY 1998, with processing operations to begin in mid-FY 1999.

- *Mediated Electrochemical Oxidation (Rocky Flats)*—The mediated electrochemical oxidation technology has been demonstrated for radioactive materials, although not in DOE production operations. Equipment would have to be installed in Building 371 adjacent to the liquid treatment facilities. Requirements for these treatment facilities by higher priority residues (e.g., combustibles) would delay the start of operations by at least four years.

- *Mediated Electrochemical Oxidation (Savannah River Site)*—Installation of the new dissolvers, start-up tests, etc. are estimated to require three years from the Record of Decision at the Savannah River Site. In the case of H-Canyon, decontamination and decommissioning of existing equipment and facilities prior to installation of the mediated electrochemical oxidation equipment is estimated to require an additional two years.

- *Repackaging under Alternative 4*—Repackaging under Alternative 4 minimizes schedule uncertainty except for sand, slag, and crucible. For sand, slag, and crucible, repackaging under Alternative 4 magnifies

schedule uncertainties by creating conflicts with the schedules at the Savannah River Site F-Canyon in particular and the Rocky Flats / Savannah River Site programs in general, including the shipment of metals and oxides from Rocky Flats to the Savannah River Site under a different EIS. The key schedule uncertainty is related to Rocky Flats' need to characterize the sand, slag, and crucible to ensure that reactivity and pyrophoricity limits are not exceeded and the Savannah River Site's need to receive and Purex process the material (if it is to be Purex processed) before Rocky Flats could complete its characterization activities. If repackaging under Alternative 4 were selected and then found unsuitable, leading to a new requirement for Purex processing at the Savannah River Site, the integrated schedules of the sites in general and F-Canyon in particular would be adversely affected.

- *Salt Distillation (Rocky Flats)*—Salt distillation has been demonstrated at a pilot scale at the Los Alamos National Laboratory with residue materials. Optimization studies are ongoing and final designs are not yet available. Capabilities for production-scale distillation could be available in 2 years at Rocky Flats.

- *Salt Distillation (Los Alamos National Laboratory)*—Salt distillation has been demonstrated at a pilot scale at the Los Alamos National Laboratory with residue materials. Optimization studies are ongoing and final designs are not yet available. Capabilities for production-scale distillation could be available in two to four years at the Los Alamos National Laboratory. Depending on the quantity of salts to be distilled at the Los Alamos National Laboratory (i.e., up to 14 metric tons of electrorefining and molten salt extraction salts), up to 6-8 years would be required for capital upgrades, installation of extra distillation units, and additional vault storage space.

- *Sonic Wash*—Sonic washing has been demonstrated with residue-type material at a bench scale. The time required to demonstrate a consistent full-scale process and develop the procedures and supporting analyses is estimated at two years.

- *Water Leach (Rocky Flats)*—Water leaching is a well-demonstrated technology for dissolving chloride salts. The equipment required for water leaching would have to be installed in Building 371 adjacent to the liquid treatment facilities. Requirements for these treatment facilities by higher priority residues (e.g., combustibles) would delay the start of operations by at least four years.

- *Water Leach (Los Alamos National Laboratory)*—The capability for water leaching is installed and operational at Los Alamos National Laboratory on a limited scale. Additional capabilities are available using a similar aqueous dissolution process. If any other capabilities were necessary they could be available in two to four years.

Ideally, all processes requiring liquid processing at Rocky Flats would follow the processing of combustibles (including combustibles below Safeguard Termination Limits) in Building 371. If the selected approach for managing plutonium fluoride residues is packaging at Rocky Flats for shipment to the Savannah River Site, fluoride packaging would follow the processing of wet combustibles, but precede the processing of dry combustibles. The insertion of fluoride packaging into the Building 371 time-line adds three to six months to the total length of operations at Rocky Flats compared to processing all the combustibles followed by fluoride packaging. The interruption is necessary to coordinate the processing windows of Rocky Flats and the Savannah River Site. Other processes that use the liquid processing capabilities of Building 371 would follow both the fluoride and the combustibles processes. Certain sequences could thus add time to the total processing duration at Rocky Flats. Depending on the selected processing options, other integration issues and shipment constraints could be expected to result in additional extensions to the total processing duration.

G.4 AVAILABILITY AND CAPABILITY OF DOE FACILITIES

This section summarizes the availability and capability of Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory to process the plutonium residues. These capabilities should be considered in the light of the technical uncertainties discussed in Sections 4.17.4 and 4.17.7 and the schedule uncertainties discussed in Section G.3.

G.4.1 Availability and Capability of Rocky Flats

Different materials processes at Rocky Flats require different facilities and technologies. Shipment to WIPP under Alternative 4 consists of repackaging materials into drums for shipment to WIPP. Repackaging is a proven technology. The capability for repackaging in the shipment to WIPP under Alternative 4 should be available for ash and salt residues before the end of FY 1998. To vitrify incinerator ash, graphite fines, and inorganic ash would require Rocky Flats to buy and install furnaces in new or modified gloveboxes. Ash vitrification has never been performed at Rocky Flats. If shipment to WIPP under Alternative 4 is not selected and technical issues related to vitrification cannot be resolved, it is likely that calcination/cementation would be selected. Purex processing of ash at the Savannah River Site is problematic because of Resource Conservation and Recovery Act permitting issues. Blending ash generates a large number of transuranic waste drums and carries high costs. Calcination and cementation of incinerator ash has been previously conducted at Rocky Flats.

Distillation of electrorefining salts and molten salt extraction salts has never been performed at Rocky Flats. All new equipment would need to be purchased and installed, and start-up issues would need to be resolved before processing. The only non-Purex option remaining if distillation is not available (for the salts that cannot be shipped using shipment to WIPP under Alternative 4) is blending, which creates large waste quantities and incurs high costs.

Pyro-oxidation at Rocky Flats is the front-end process for the processing options that ship the salt to the Los Alamos National Laboratory for further processing. Since pyro-oxidation has been identified as a stabilization technology to be used prior to storage or shipment, it is possible that distillation could still be performed without pyro-oxidation. However, since pyro-oxidation is required for transportation, non-pyro-oxidized direct oxide reduction salts could not be sent to Los Alamos National Laboratory. The next alternative for front-end processing at Rocky Flats would likely be salt scrub, which generates scrub alloy that can be Purex-processed at the Savannah River Site. The salt scrub process is, however, in question for some portion of the salts that have oxidized or absorbed moisture over time. The only remaining option for pyro-oxidized direct oxide reduction salts is blending, which creates large quantities of transuranic waste. Pyro-oxidized salts cannot be Purex-processed.

With respect to aqueous combustibles and glass residues, Rocky Flats has both the availability and the capability in place to neutralize/dry these residues, with no increase in capital expenditures. With respect to dry combustibles, graphite, and inorganics, Rocky Flats has both the availability and the capability in place to repackage these residues, with no increase in capital expenditures. With respect to organic-contaminated combustibles, Rocky Flats has never performed the preferred thermal desorption/steam passivation process. If thermal desorption/steam passivation is not feasible, Rocky Flats could select from several other options, including mediated electrochemical oxidation, sonic wash, catalytic chemical oxidation, and blend down.

G.4.2 Availability and Capability of the Savannah River Site

Purex processing at the Savannah River Site's F-Canyon is part of the preferred alternative for sand, slag, and crucible; plutonium fluorides; and scrub alloy. Purex processing of these residues at the Savannah River Site is included in the current site schedules and thus adds no time to the planned operation of the canyons. Purex processing of other residues or mediated electrochemical oxidation of any residues would affect canyon operating schedules and plans for shutting down the canyons.

If F-Canyon is shut down before it can complete processing of all scheduled shipments from Rocky Flats, or if residues scheduled for some other form of management (especially salts and ash) ultimately cannot be processed as planned, the costs for management outside of F-Canyon Purex could be very high. The Savannah River Site's H-Canyon is technically suited to Purex processing of the Rocky Flats residues but requires more time and has higher costs.

Similarly, although F-Canyon and H-Canyon could complete the mediated electrochemical oxidation process on suitable residues in about the same processing time, mediated electrochemical oxidation at H-Canyon would require an up-front expenditure of $20 million for decontamination and decommissioning of contaminated equipment. The decontamination and decommissioning process at H-Canyon would take 2 years, generate 60 rem, and generate additional transuranic and low-level waste (WSRC 1997). Installation of two Silver II electrochemical dissolvers (at either F-Canyon or H-Canyon) for mediated electrochemical oxidation would require 3 years.

While the Savannah River Site could Purex-process all of the Rocky Flats salts if they were scrubbed, it could not Purex-process any of them if they were pyro-oxidized. The pyro-oxidation issue is particularly acute for IDC 409 and other molten salt extraction salts (because of the americium). In this case, it is conceivable that if post-oxidation distillation or water leaching fails, the only remaining non-Purex processing option would be blending.

The Savannah River Site does not currently have the capability to receive and store americium-rich transuranic oxides that would be produced at the Los Alamos National Laboratory through acid dissolution. This capability is expected to be available when the new Actinide Packaging and Storage Facility is opened in 2001. It does have the capability to store the plutonium-americium output from distillation at the Los Alamos National Laboratory.

G.4.3 Availability and Capability of the Los Alamos National Laboratory

The Los Alamos National Laboratory Plutonium Facility currently has the aqueous chloride and aqueous nitrate capability to support the disposition of IDC 365, 413, 427, and other direct oxide reduction salt residues. The aqueous chloride capacity could also be enhanced significantly with the final installation of the already constructed chloride extraction and actinide recovery line. Water leaching, which is a subset of the aqueous processing capacity, is also applicable to these salt residues. Although the process is still under development, it could simplify the processing scheme and reduce secondary waste generation.

With the installation of new salt distillation units within the pyrochemical area, the Los Alamos National Laboratory could distill the IDC 409 and other electrorefining and molten salt extraction salts. As a contingency, residues that are not adequately treated by the salt distillation process could be managed through the available aqueous capacity.

Los Alamos National Laboratory has the interim capability to store the americium-rich transuranic oxides resulting from the aqueous dissolution processes and distillation processes available for management of the various salt residues.

G.4.4 Resource Conservation and Recovery Act Designation

Some materials, such as ash, have Resource Conservation and Recovery Act designation. Processing of Resource Conservation and Recovery Act materials requires treatment permits. Unless the Savannah River Site gets a Resource Conservation and Recovery Act treatment, storage, and disposal permit, it cannot accept ash for temporary storage, treatment, or final disposition. WIPP is qualified to handle the Resource Conservation and Recovery Act wastes generated from the plutonium processing activities at Rocky Flats (subject to permitting) but the proposed high-level geologic repository is not planned as a Resource Conservation and Recovery Act-qualified site. This raises certain issues regarding the ability of the Savannah River Site to accept certain residues and the disposition of Resource Conservation and Recovery Act wastes in high-level waste generated by the Savannah River Site's Defense Waste Processing Facility. No cost or schedule impacts for this issue have been determined.

G.5 ESTIMATED ABSOLUTE AND INCREMENTAL COSTS FOR EACH PROCESSING OPTION

Table G–12 shows the individually allocable undiscounted absolute and incremental costs, respectively, in 1997 dollars for each processing option. Absolute costs at each site are the sum of direct and indirect labor (including site overheads) for processing and waste management; high-level waste, low-level waste, and transuranic waste packaging, shipping, and disposal; Safe, Secure Trailer shipping (if required), and 3013 packaging and on-site storage (if required). Incremental costs are determined by subtracting the absolute costs for individual processing options from the absolute cost for the No Action Alternative processing option, including costs for interim storage of stabilized residues and transuranic waste.

Costs for itemized equipment (excluding distillation equipment and vault upgrades at Los Alamos National Laboratory in the cases for distillation of electrorefining and molten salt extraction salts) must be added separately, depending on how many options share a piece of itemized equipment in a particular alternative. These itemized equipment costs are listed in the second paragraph of Section G.1.1. In the Preferred Alternative and the Minimum Duration Management Approach, no itemized equipment is required. In the Minimum Cost Management Approach, $4 million is required for distillation equipment at Rocky Flats. The only management approach requiring more than $4 million in itemized equipment is the Maximum Plutonium Separation Management Approach, which incurs $64 million in itemized costs. Of this $64 million, $4 million is for distillation equipment at Rocky Flats, $30 million is for mediated electrochemical oxidation equipment at Rocky Flats and $30 million is for mediated electrochemical oxidation equipment at the Savannah River Site F-Canyon[3].

Other important factors include:

- Costs for common facilities and equipment (typically $180 million) and research and development ($10 million) are not decisional to the present EIS and are excluded from the table.

- Costs for processing at Rocky flats under the No Action Alternative and Rocky Flats under the No Action Alternative are shown separately. Cost for interim storage in the No Action Alternative are allocated according to the percentage of drums of stabilized residues and transuranic waste for each processing option against a fixed cost of $23 million per year for 20 years to keep the site open for storage and surveillance.

- Values in the MD (i.e., materials disposition) column represent fixed and variable to dispose of separated fissile materials. No particular site is associated with these costs.

- Values in the WIPP column represent variable costs to dispose of transuranic waste at WIPP.

- The costs for salt pyro-oxidation as a No Action processing option at Rocky Flats exceed the costs for the pyro-oxidation phase of processes at Rocky Flats that ship the salts to the Los Alamos National Laboratory for further processing. Pro-oxidation as a No Action processing option requires different and more expensive processing for stabilization than for production of an input to the distillation, acid dissolution, or water leaching processing options.

[3] *To achieve maximum plutonium separation, mediated electrochemical oxidation would be required at Rocky Flats and the Savannah River Site. This is a highly uneconomical and inefficient way to increase the quantity of separated plutonium and would not be selected even if plutonium separation were an objective.*

Absolute and incremental costs should be viewed in the light of the discussions on labor multipliers in Section G.1.12. Costs for itemized, shared equipment, summarized in Section G.1.1 must be added separately.

Table G–12 Individually Allocable Absolute and Incremental Costs, Millions of Undiscounted 1997 Dollars (Excluding Itemized, Shared Equipment)

Material	*Process*	*Rocky Flats*	*Rocky Flats (Excluding Interim Storage)*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*MD*	*Absolute*	*Incremental*
Incinerator Ash	Calcine & Cement at Rocky Flats	165	99	0	0	1	0	264.39	
Incinerator Ash	Vitrification at Rocky Flats	86	0	0	0	1	0	86.63	-178
Incinerator Ash	Cold Ceramification at Rocky Flats	85	0	0	0	1	0	85.53	-179
Incinerator Ash	Blend Down at Rocky Flats	113	0	0	0	1	0	113.42	-151
Incinerator Ash	Fusion at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	22	0	144	0	0	33	198.04	-66
Incinerator Ash	Fusion at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	22	0	390	0	0	33	444.69	180
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	17	0	130	0	0	33	179.91	-84
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	17	0	126	0	0	33	176.42	-88
Incinerator Ash	Calcine & Cement at Rocky Flats (Alternative 4)	164	0	0	0	1	0	164.70	-100
Incinerator Ash	Repackage at Rocky Flats (Alternative 4)	57	0	0	0	1	0	57.82	-207
Sand, Slag, & Crucible	Calcine & Cement at Rocky Flats	27	22	0	0	0	0	49.15	
Sand, Slag, & Crucible	Vitrification at Rocky Flats	16	0	0	0	0	0	16.18	-33
Sand, Slag, & Crucible	Blend Down at Rocky Flats	21	0	0	0	0	0	20.72	-28
Sand, Slag, & Crucible	Repackage and Purex Process at the Savannah River Site F-Canyon	4	0	27	0	0	5	35.56	-14
Sand, Slag, & Crucible	Repackage and Purex process at the Savannah River Site H-Canyon	4	0	61	0	0	5	69.23	20
Sand, Slag, & Crucible	Calcine & Cement at Rocky Flats (Alternative 4)	21	0	0	0	0	0	20.68	-28
Sand, Slag, & Crucible	Repackage at Rocky Flats (Alternative 4)	11	0	0	0	0	0	10.79	-38
Graphite Fines	Cement at Rocky Flats	11	6	0	0	0	0	17.04	-32
Graphite Fines	Vitrification at Rocky Flats	6	0	0	0	0	0	6.17	-11
Graphite Fines	Blend Down at Rocky Flats	7	0	0	0	0	0	7.42	-10
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	1	0	9	0	0	3	13.00	-4

Material	*Process*	*Rocky Flats*	*Rocky Flats (Excluding Interim Storage)*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*MD*	*Absolute*	*Incremental*
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	1	0	9	0	0	3	12.78	-4
Graphite Fines	Cement at Rocky Flats (Alternative 4)	11	0	0	0	0	0	10.70	-6
Graphite Fines	Repackage at Rocky Flats (Alternative 4)	4	0	0	0	0	0	3.80	-13
Inorganic Ash	Calcine & Cement at Rocky Flats	14	14	0	0	0	0	28.51	
Inorganic Ash	Vitrification at Rocky Flats	9	0	0	0	0	0	9.42	-19
Inorganic Ash	Blend Down at Rocky Flats	12	0	0	0	0	0	11.78	-17
Inorganic Ash	Calcine & Cement at Rocky Flats (Alternative 4)	14	0	0	0	0	0	14.07	-14
Inorganic Ash	Repackage at Rocky Flats (Alternative 4)	8	0	0	0	0	0	7.94	-21
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats	26	32	0	0	0	0	57.75	
MSE/ER Salts (IDC 409)	Blend Down at Rocky Flats	44	0	0	0	0	0	43.88	-14
MSE/ER Salts (IDC 409)	Distillation at Rocky Flats	9	0	0	0	0	9	17.64	-40
MSE/ER Salts (IDC 409)	Water Leach at Rocky Flats	44	0	0	0	0	8	52.13	-6
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats and distillation at Los Alamos National Laboratory	7	0	0	43	0	9	58.20	0
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	8	0	5	0	0	8	22.15	-36
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	8	0	7	0	0	8	23.84	-34
MSE/ER Salts (IDC 409)	Pyro-oxidize, Blend, Repackage (Alternative 4)	19	0	0	0	0	0	19.15	-39
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats	69	86	0	0	1	0	155.01	
MSE/ER Salts (All Others)	Blend Down at Rocky Flats	175	0	0	0	1	0	176.54	22
MSE/ER Salts (All Others)	Distillation at Rocky Flats	25	0	0	0	0	21	45.41	-110
MSE/ER Salts (All Others)	Water Leach at Rocky Flats	186	0	0	0	2	20	207.58	53

Material	*Process*	*Rocky Flats*	*Rocky Flats (Excluding Interim Storage)*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*MD*	*Absolute*	*Incremental*
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats and Distillation at Los Alamos National Laboratory	18	0	0	132	0	20	170.90	16
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	26	0	39	0	0	20	85.92	-69
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	26	0	52	0	0	20	98.87	-56
MSE/ER Salts (All Others)	Pyro-oxidize (Alternative 4)	67	0	0	0	1	0	67.95	-87
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats	18	13	0	0	0	0	31.26	
DOR Salts (IDCs 365, 413, 427)	Blend Down at Rocky Flats	24	0	0	0	0	0	24.38	-7
DOR Salts (IDCs 365, 413, 427)	Water Leach at Rocky Flats	25	0	0	0	0	5	29.61	-2
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	1	0	0	10	0	5	16.99	-14
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	1	0	0	11	0	5	17.55	-14
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site F-Canyon	5	0	3	0	0	5	12.47	-19
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex process at the Savannah River Site H-Canyon	5	0	4	0	0	5	13.30	-18
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize, Blend, Repackage (Alternative 4)	13	0	0	0	0	0	12.75	-19
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats	8	7	0	0	0	0	14.84	
DOR Salts (All Others)	Blend Down at Rocky Flats	18	0	0	0	0	0	18.07	3
DOR Salts (All Others)	Water Leach at Rocky Flats	22	0	0	0	0	2	23.54	9
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	1	0	0	16	0	2	19.06	4
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	1	0	0	16	0	2	19.05	4

Material	*Process*	*Rocky Flats*	*Rocky Flats (Excluding Interim Storage)*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*MD*	*Absolute*	*Incremental*
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	3	0	5	0	0	2	9.49	-5
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	3	0	7	0	0	2	11.16	-4
DOR Salts (All Others)	Pyro-oxidize (Alternative 4)	8	0	0	0	0	0	7.92	-7
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats	5	9	0	0	0	0	14.32	
Aqueous-Contaminated Combustibles	Sonic Wash at Rocky Flats	4	0	0	0	0	0	4.00	-10
Aqueous-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	13	0	0	0	0	0	13.20	-1
Aqueous-Contaminated Combustibles	Blend Down at Rocky Flats	1	0	0	0	0	0	1.51	-13
Aqueous-Contaminated Combustibles	Mediated Electrochemical Oxidation	7	0	0	0	0	0	7.86	-6
Aqueous-Contaminated Combustibles	Neutralize/Dry (Alternative 4)	5	0	0	0	0	0	5.20	-9
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats	6	6	0	0	0	0	12.11	
Organic-Contaminated Combustibles	Sonic Wash at Rocky Flats	3	0	0	0	0	0	2.72	-9
Organic-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	8	0	0	0	0	0	8.20	-4
Organic-Contaminated Combustibles	Blend Down at Rocky Flats	1	0	0	0	0	0	0.97	-11
Organic-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	4	0	0	0	0	0	4.53	-8
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation (Alternative 4)	6	0	0	0	0	0	5.68	-6
Dry Combustibles	Repackage at Rocky Flats	2	5	0	0	0	0	7.30	
Dry Combustibles	Sonic Wash at Rocky Flats	2	0	0	0	0	0	2.29	-5
Dry Combustibles	Catalytic Chemical Oxidation at Rocky Flats	8	0	0	0	0	0	7.57	0
Dry Combustibles	Blend Down at Rocky Flats	1	0	0	0	0	0	0.86	-6
Dry Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	4	0	0	0	0	0	4.62	-3
Dry Combustibles	Repackage at Rocky Flats (Alternative 4)	2	0	0	0	0	0	2.12	-5

Material	*Process*	*Rocky Flats*	*Rocky Flats (Excluding Interim Storage)*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*MD*	*Absolute*	*Incremental*
Plutonium Fluorides	Acid Dissolution at Rocky Flats	17	3	0	0	0	0	20.43	
Plutonium Fluorides	Blend Down at Rocky Flats	61	0	0	0	1	0	61.18	41
Plutonium Fluorides	Acid Dissolution at Rocky Flats	17	0	0	0	0	5	21.84	1
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	1	0	12	0	0	5	18.00	-2
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	1	0	32	0	0	5	38.29	18
Ful Flo Filter Media	Neutralize/Dry at Rocky Flats	15	34	0	0	0	0	49.24	
Ful Flo Filter Media	Blend Down at Rocky Flats	4	0	0	0	0	0	3.67	-46
Ful Flo Filter Media	Sonic Wash at Rocky Flats	6	0	0	0	0	0	5.76	-43
Ful Flo Filter Media	Mediated Electrochemical Oxidation at Rocky Flats	10	0	0	0	0	1	11.09	-38
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats	38	73	0	0	0	0	111.47	
HEPA Filters (IDC 338)	Vitrification at Rocky Flats	11	0	0	0	0	0	10.61	-101
HEPA Filters (IDC 338)	Blend Down at Rocky Flats	10	0	0	0	0	0	10.42	-101
HEPA Filters (IDC 338)	Sonic Wash at Rocky Flats	18	0	0	0	0	0	18.32	-93
HEPA Filters (IDC 338)	Mediated Electrochemical Oxidation at Rocky Flats	26	0	0	0	0	3	29.87	-82
HEPA Filters (IDC 338)	Neutralize/Dry (Alternative 4)	38	0	0	0	0	0	38.59	-73
HEPA Filters (All Others)	Neutralize/Dry at Rocky Flats	1	2	0	0	0	0	3.29	
HEPA Filters (All Others)	Vitrification at Rocky Flats	1	0	0	0	0	0	0.56	-3
HEPA Filters (All Others)	Blend Down at Rocky Flats	1	0	0	0	0	0	0.80	-2
HEPA Filters (All Others)	Sonic Wash at Rocky Flats	1	0	0	0	0	0	0.76	-3
HEPA Filters (All Others)	Mediated Electrochemical Oxidation at Rocky Flats	1	0	0	0	0	0	1.59	-2
HEPA Filters (All Others)	Blend and Repackage at Rocky Flats (Alternative 4)	1	0	0	0	0	0	1.04	-2
Sludge (IDCs 089, 099, 332)	Filter/Dry at Rocky Flats	0	1	0	0	0	0	1.47	

Material	*Process*	*Rocky Flats*	*Rocky Flats (Excluding Interim Storage)*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*MD*	*Absolute*	*Incremental*
Sludge (IDCs 089, 099, 332)	Vitrification at Rocky Flats	0	0	0	0	0	0	0.07	-1
Sludge (IDCs 089, 099, 332)	Blend Down at Rocky Flats	0	0	0	0	0	0	0.12	-1
Sludge (IDCs 089, 099, 332)	Blend and Repackage at Rocky Flats (Alternative 4)	0	0	0	0	0	0	0.11	-1
Sludge (All Others)	Filter/Dry at Rocky Flats	12	25	0	0	0	0	36.62	
Sludge (All Others)	Vitrification at Rocky Flats	3	0	0	0	0	0	3.24	-33
Sludge (All Others)	Blend Down at Rocky Flats	3	0	0	0	0	0	3.20	-33
Sludge (All Others)	Acid Dissolution at Rocky Flats	21	0	0	0	0	1	21.58	-15
Sludge (All Others)	Filter/Dry at Rocky Flats (Alternative 4)	12	0	0	0	0	0	11.86	-25
Glass	Neutralize/Dry at Rocky Flats	0	0	0	0	0	0	0.48	-0
Glass	Vitrification at Rocky Flats	1	0	0	0	0	0	0.60	-0
Glass	Blend Down at Rocky Flats	1	0	0	0	0	0	0.63	-0
Glass	Sonic Wash at Rocky Flats	1	0	0	0	0	0	1.04	
Glass	Mediated Electrochemical Oxidation at Rocky Flats	2	0	0	0	0	0	2.11	1
Glass	Neutralize/Dry (Alternative 4)	0	0	0	0	0	0	0.48	-0
Graphite	Repackage at Rocky Flats	8	13	0	0	0	0	21.25	
Graphite	Cement at Rocky Flats	9	0	0	0	0	0	9.54	-12
Graphite	Vitrification at Rocky Flats	10	0	0	0	0	0	10.14	-11
Graphite	Blend Down at Rocky Flats	10	0	0	0	0	0	9.93	-11
Graphite	Mediated Electrochemical Oxidation at Rocky Flats	29	0	0	0	0	3	32.43	11
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	3	0	30	0	0	4	36.18	15
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	3	0	29	0	0	4	34.91	14
Graphite	Repackage at Rocky Flats (Alternative 4)	8	0	0	0	0	0	8.24	-13
Inorganics	Repackage at Rocky Flats	2	2	0	0	0	0	3.98	
Inorganics	Vitrification at Rocky Flats	2	0	0	0	0	0	1.87	-2
Inorganics	Blend Down at Rocky Flats	2	0	0	0	0	0	2.05	-2
Inorganics	Mediated Electrochemical Oxidation at Rocky Flats	6	0	0	0	0	1	7.12	3

Material	*Process*	*Rocky Flats*	*Rocky Flats (Excluding Interim Storage)*	*Savannah River Site*	*Los Alamos National Laboratory*	*WIPP*	*MD*	*Absolute*	*Incremental*
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F-Canyon	1	0	5	0	0	1	6.14	2
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H-Canyon	1	0	5	0	0	1	6.01	2
Inorganics	Repackage at Rocky Flats (Alternative 4)	2	0	0	0	0	0	1.58	-2
Scrub Alloy	Repackage at Rocky Flats	3	6	0	0	0	0	9.27	
Scrub Alloy	Calcine and Vitrification at Rocky Flats	68	0	0	0	0	0	68.40	59
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	1	0	12	0	0	7	20.39	11
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site H-Canyon	1	0	16	0	0	7	24.44	15

MD = materials disposition MSE/ER = molten salt extraction/electrorefining DOR = direct oxide reduction HEPA = high-efficiency particulate air

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