Chapter 2 of this Summary presents information on:

Description of Alternatives

DOE Sites Considered

Technology Screening Process

Description of Technologies

Preferred Processing Options

Interim Storage

Ultimate Disposition

Transportation

Proliferation Concerns

2.0 PROPOSED ACTION AND ALTERNATIVES

The "proposed action" is to process certain plutonium residues and scrub alloy currently stored at Rocky Flats, if necessary, when those plutonium residues and scrub alloy have plutonium concentrations above the safeguards termination limits. Processing is needed to address immediate health and safety concerns regarding storage of the plutonium residues and scrub alloy, as raised by the Defense Nuclear Facilities Safety Board in Recommendation 94-1, and to prepare these materials for offsite disposal as transuranic waste in WIPP or for other disposition. Disposal or other disposition would eliminate worker exposure and potential accident risks that would be associated with continued storage of these materials. The term "processing" as used in this EIS always includes repackaging. In some cases, repackaging may be the only operation conducted. These cases are specifically identified and described in Section 2.4 of the Final EIS.

The proposed action could be accomplished by using a mix of alternatives evaluated in this EIS for the different material categories. This chapter describes the alternatives evaluated under three action alternatives and the "No Action" Alternative. Included is a description of the alternatives, the sites being considered, the procedure used to screen and select alternative technologies for evaluation, and a summary of each processing technology evaluated. For each of the material types, a preferred processing technology has been identified and highlighted. Discussions of interim storage, transportation of the materials, and disposition are also presented, followed by a discussion of proliferation concerns.

2.1 DESCRIPTION OF ALTERNATIVES

The alternatives evaluated in this EIS, along with the DOE sites considered for implementing the alternatives, are presented in Figure S-1 and are discussed below.

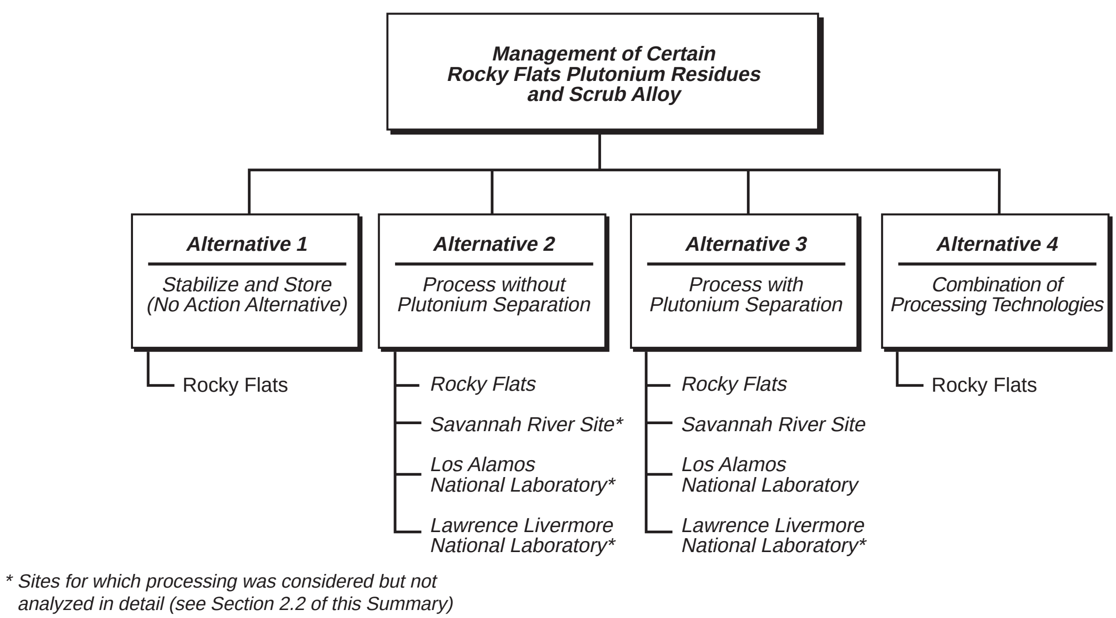


Figure S-1. Alternatives Evaluated in this EIS

The processing technologies for the No Action Alternative are as given in the Rocky Flats Solid Residue Environmental Assessment. In selecting the processing technologies for Alternatives 2, 3, and 4, DOE initially screened and selected candidate processing technologies for all the categories of residues (ash, pyrochemical salts, wet residues, and direct repackage residues) and for the scrub alloy. Only those processing technologies that are mature enough for implementation in the 1998-2004 timeframe were selected for detailed evaluation.

Alternative 1 (No Action - Stabilize and Store)

This alternative consists of stabilization or repackaging to prepare the material for interim storage as described in the Rocky Flats Solid Residue Environmental Assessment. Under this alternative, further processing would not occur to prepare the material for disposal at WIPP or other disposition. This is referred to as the "No Action" Alternative. 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 way to know what the length of the storage period would be, the annual impacts of storage have been determined. To illuminate the impacts of extended storage, DOE has also determined the impacts of a 20-year storage period for the residues and scrub alloy. 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 immediate health and safety concerns associated with near-term storage conditions, the health and safety risks associated with potential long-term storage of these materials at Rocky Flats would remain unabated.

Depending on the material category, technologies under this alternative include calcination, cementation, pyro-oxidation, neutralization, thermal desorption, steam passivation, repackaging, acid dissolution/ plutonium oxide recovery, and filtration. These technologies would be implemented onsite at Rocky Flats. The specific materials analyzed for technologies under Alternative 1 are identified in Figure S-3 in Section 2.4 of this Summary.

Alternative 2 (Processing without Plutonium Separation)

Under this alternative, the materials would be processed to convert them into forms that would meet safeguards termination limits. The materials would be ready for shipment to WIPP for disposal.

Depending on the material category, technologies that could be used include immobilization (e.g., cementation, calcination/vitrification, and cold ceramification), blend down, catalytic chemical oxidation (digestion), and sonic wash. These technologies would be implemented onsite at Rocky Flats. The specific materials analyzed for technologies under Alternative 2 are identified in Figure S-3 in Section 2.4 of this Summary.

Alternative 3 (Processing with Plutonium Separation)

Under this alternative, the material would be processed to separate plutonium from the material and concentrate it so that the secondary waste would meet safeguards termination limits and would be ready for shipment to WIPP, while the separated and concentrated plutonium would be placed in safe and secure storage pending disposition in accordance with decisions to be made under the Surplus Plutonium Disposition Environmental Impact Statement. DOE would not use this plutonium for nuclear explosive purposes.

Depending on the material category, processing technologies that could be used include acid dissolution/ plutonium oxide recovery, Purex process/plutonium metal or oxide recovery, mediated electrochemical oxidation, salt distillation, salt scrub, and water leach. Processing and storage activities under Alternative 3 could be performed at Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory. The specific materials analyzed for technologies under Alternative 3 are identified in Figure S-3 in Section 2.4 of this Summary.

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). 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 of this Summary).

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 granted.

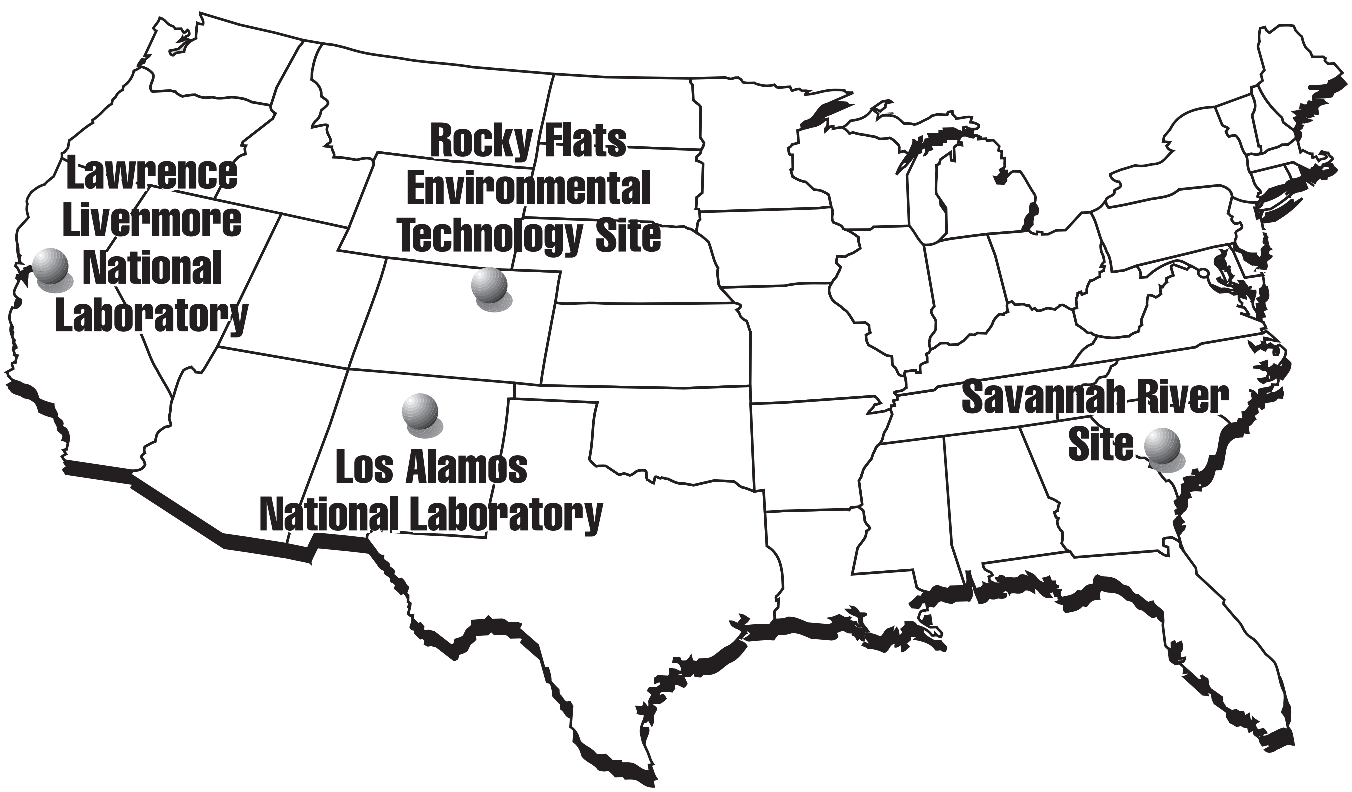
Alternative 4 allows analysis of alternatives for management of those categories of residues for which a variance to safeguards termination limits has been granted, as described in Section 1.3.1 of this Summary. Certain residues, such as plutonium fluorides, Ful Flo filter media, and scrub alloy, are 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. Accordingly, application of a variance was not considered for the Final EIS.

The processing technologies for each of these alternatives are described in more detail in Section 2.4 of this Summary.

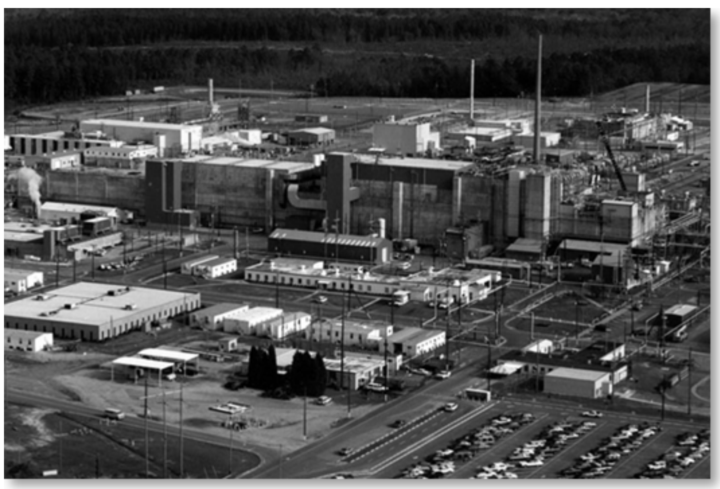
2.2 DOE SITES CONSIDERED FOR IMPLEMENTING THE ALTERNATIVES

Processing and storage activities under Alternative 1 (No Action - Stabilize and Store) would be performed at Rocky Flats as part of existing activities. Processing activities under Alternative 2 (Processing without Plutonium Separation) and Alternative 4 (Combination of Processing Technologies) would also be performed at Rocky Flats. For processing activities under Alternative 3 (Processing with Plutonium Separation), DOE is considering three DOE sites for implementation: Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory.

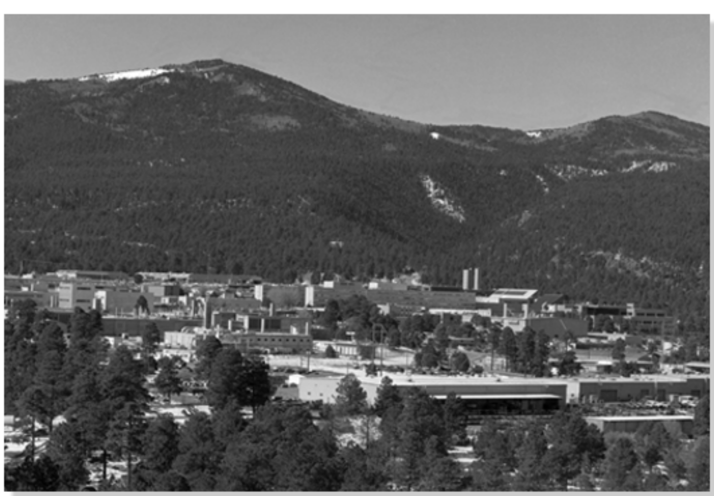
Based on the screening and evaluation process implemented for this EIS, DOE is considering Rocky Flats for 15 processes with and without plutonium separation, the Savannah River Site for two processes with plutonium separation, and Los Alamos National Laboratory for three processes with plutonium separation. These sites were selected as potential processing sites because they currently manage, or have managed in the past, plutonium residues and scrub alloy. Lawrence Livermore National Laboratory was initially considered a potential processing site under Alternatives 2 and 3, but is subject to operational constraints that precluded it from further consideration. DOE's rationale for consideration of each of these sites is further discussed below.



Rocky Flats
Environmental Technology Site



Savannah River Site's
F-Canyon



Los Alamos
National Laboratory

Rocky Flats Environmental Technology Site

For Alternative 2 (Processing without Plutonium Separation), DOE eliminated all sites from consideration except Rocky Flats. The transport of the materials to another site for processing would involve preprocessing at Rocky Flats, which would entail risks to the public and workers of essentially the same magnitude as the risks from doing all of the processing at Rocky Flats. Furthermore, transportation of the materials to a different processing site would impose additional, although small, risks to the public and transportation workers. Finally, processing the material at another site could entail risks to the public and workers at that site. The sum of the costs and risks of preprocessing, transportation, and final processing would exceed that of final processing at Rocky Flats without providing any tangible benefits. Accordingly, all processing of the plutonium residues and scrub alloy that does not involve plutonium separation would be accomplished at Rocky Flats. This includes processing under Alternative 4 (Combination of Processing Technologies). Rocky Flats is also being considered for processing under Alternative 3 (Processing with Plutonium Separation).

Processing of plutonium residues and scrub alloy at Rocky Flats would be conducted in Buildings 371 and 707. Building 371 is a four-level facility that currently stores special nuclear material, plutonium residues and wastes. It was built to nuclear design standards. Building 707 is a two-story structure that currently stores smaller amounts of plutonium residues and wastes. It was built to industrial standards.

Savannah River Site

For Alternative 3 (Processing with Plutonium Separation), the Savannah River Site has unique operational facilities for the separation of plutonium. The F-Canyon, FB-Line, H-Canyon, and HB-Line were designed to separate plutonium and uranium from other materials. Because these facilities would already be in operation to stabilize and/or process corroding spent fuel and targets, it would be efficient to also use them to process materials from Rocky Flats.

Los Alamos National Laboratory

Because Los Alamos National Laboratory is the site at which much of the technology used in the production of the Nation's nuclear weapons stockpile was developed, it has the capability to implement essentially all 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 use as a production operation. Furthermore, Los Alamos National Laboratory's processing capability has been committed, for the most part, to other programs (e.g., to process the backlog of residues from Los Alamos' previous operations and to manage wastes from manufacture of plutonium components for nuclear weapons). As a result, DOE determined that much of the processing that might be performed on the Rocky Flats plutonium residues and scrub alloy could not reasonably be conducted at Los Alamos National Laboratory. Nevertheless, DOE concluded that Los Alamos National Laboratory should be considered for three processing technologies considered in this EIS (under Alternative 3). Scientists at the site 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 processing technology and, therefore, is considered in this EIS for salt distillation. Los Alamos National Laboratory is also being considered for acid dissolution and water leach of direct oxide reduction salts because of its experience with salt processing and Rocky Flats' limited capability for processing aqueous waste.

Processing of salt residues at Los Alamos National Laboratory would be conducted in Plutonium Facility-4 in Technical Area 55. This facility is a two-story laboratory, designated as a nonreactor nuclear facility. It was built to comply with seismic standards for Safeguards Category-I buildings.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory has also developed technologies for use in the production of nuclear weapons, but the site has facility capacity and capability limitations similar to those discussed above for Los Alamos National Laboratory. In addition, Lawrence Livermore National Laboratory is subject to constraints imposed by an existing agreement with the State of California that limits the amount of plutonium that may be present at the site at any one time. This limitation would require that most, if not all, of any residues processed at Lawrence Livermore National Laboratory be shipped to another DOE site for storage prior to disposal. This requirement would result in additional shipment preparation and transportation impacts, without any advantage to offset such effects. As a result, DOE has eliminated Lawrence Livermore National Laboratory from further consideration as a site for the processing of Rocky Flats plutonium residues or scrub alloy.

The maximum amounts of materials that could be processed under this EIS at each of the sites are given in Figure S-2. The breakdown by material category is given in Table S-3.

2.3 PROCESS USED TO SCREEN AND SELECT PROCESSING TECHNOLOGIES FOR EVALUATION

DOE used a screening process to identify a reasonable set of processing technologies for detailed evaluation in this EIS. The screening process assessed a wide range of potential processing technologies identified in several DOE studies, including the following:

- *Environmental Assessment, Finding of No Significant Impact, and Response to Comments - Solid Residue Treatment, Repackaging, and Storage*, DOE/EA-1120, (April 1996)
- *Rocky Flats Environmental Technology Site: Direct Disposal Trade Study for Plutonium-Bearing Residues* (November 1995)
- A series of trade studies on specific material categories prepared by the DOE Nuclear Material Stabilization Task Group. These are technical studies which evaluate "trade offs" of variables such as health impacts, amounts of wastes generated, and costs. The studies include:

  Plutonium Combustibles Trade Study (December 1996)

  Plutonium Salts Trade Study (February 1996)

  Plutonium Sand, Slag, and Crucible Trade Study (January 1997)

  Ash Residues End-State Trade Study (October 1996)

  Plutonium Scrub Alloy Trade Study (February 1996)
- *Residue Program Rebaselining: Phase I Recommendation for Rebaselining Salts, SS&C, and Graphite Fines* (the Rocky Flats Rebaselining Study) (December 1996)
- *Residue Program Rebaselining: Phase II Recommendation for Rebaselining Ash, Combustibles, Fluorides, Sludges, Glass, and Firebrick and Inorganics* (January 1997)

After identifying a preliminary set of processing technologies from these studies, DOE 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 1998-2004 timeframe within reasonable cost,
- experience of the DOE site in employing the technology and availability of facilities and equipment,
- minimization of the number of process steps to minimize worker exposures, and
- amount of secondary wastes generated and 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

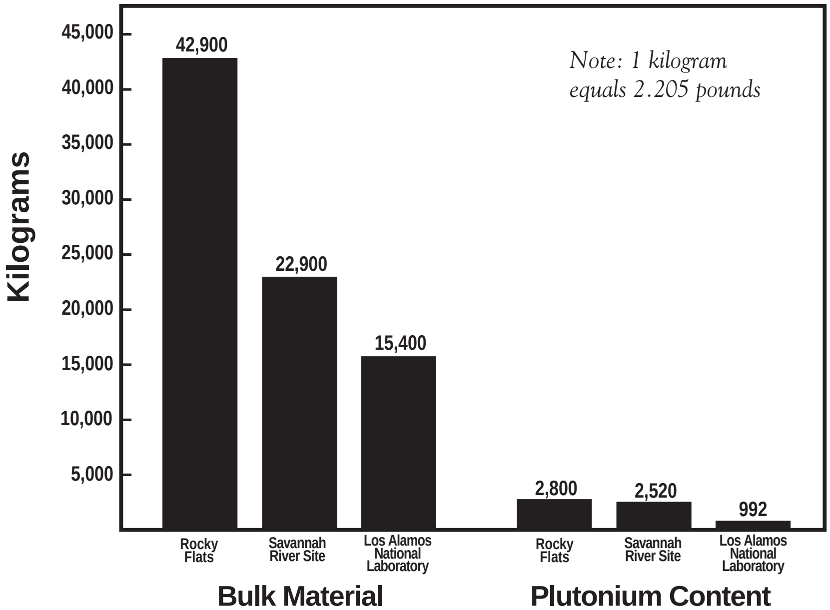
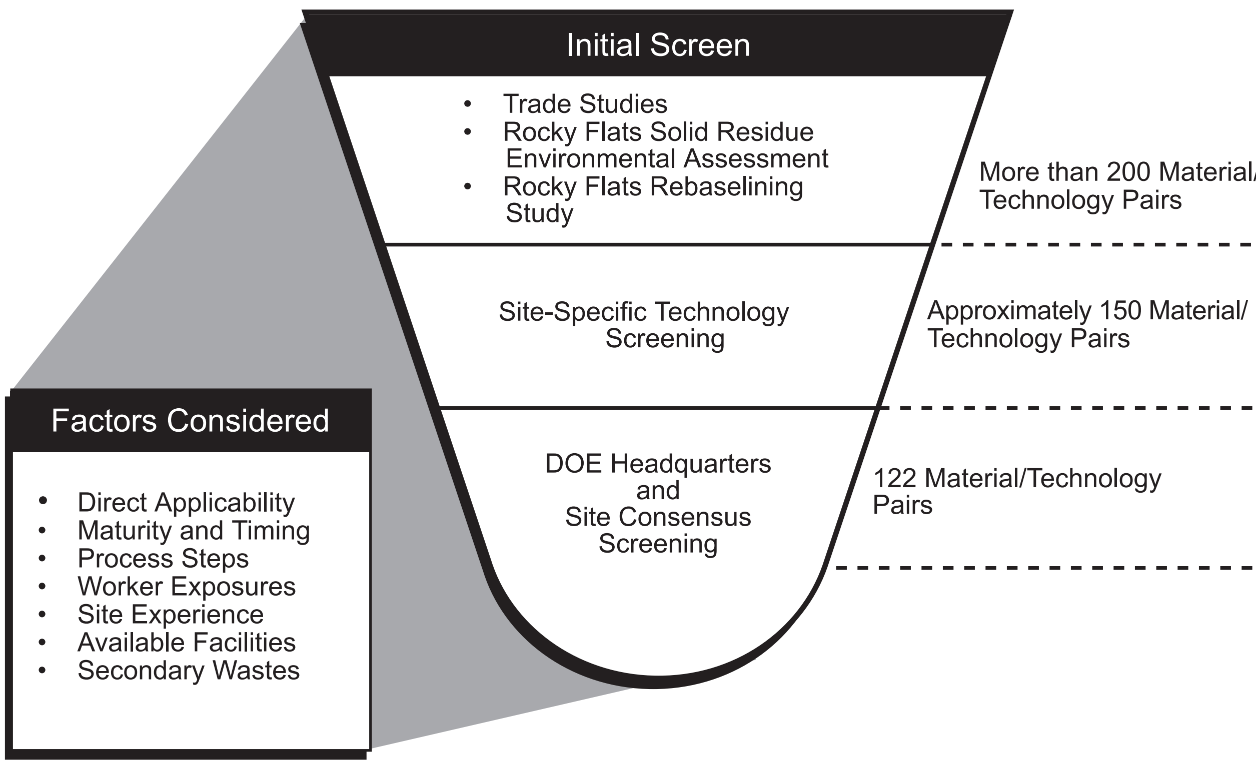


Figure S-2. Maximum Amounts of Plutonium Residues and Scrub Alloy That Could Be Processed at Each Site

Rocky Flats	Bulk (kg)	Plutonium (kg)
Ash	20,060	1,160
Salts	14,900	1,000
Combustibles	1,140	21
Fluorides	315	142
Filters	2,630	112
Sludge	620	27
Glass	133	5
Graphite	1,880	97
Inorganic	460	18
Scrub Alloy	700	200
Total	~ 42,900	~ 2,800
Savannah River Site	**Bulk (kg)**	**Plutonium (kg)**
Ash	16,400	1,100
Salts (after scrub)	3,210	964
Fluorides	312	141
Graphite	1,860	96.4
Inorganic	444	17.5
Scrub Alloy	700	200
Total	~ 22,900	~ 2,520
Los Alamos National Laboratory	**Bulk (kg)**	**Plutonium (kg)**
Salts	15,400	992

Notes: 1 kg equals 2.205 pounds
Preprocessing at Rocky Flats generally reduces the amounts of material that would be sent to the Savannah River Site or to Los Alamos National Laboratory for processing.

Table S-3. Maximum Amounts of Material (by Category) That Could Be Processed at Each Site the desired timeframe. An attempt was made to select processes for evaluation in this EIS that included at least one process that did not involve plutonium separation and one that involved plutonium separation for each material category. These discussions, plus considerations of public comments received on the Draft EIS and additional information obtained as the result of further characterization of the residues and scrub alloy, were the bases for selecting the technologies included in this EIS.



2.4 DESCRIPTION OF PROCESSING TECHNOLOGIES (OPTIONS)

This section presents a summary description of processing technologies evaluated in this EIS for the various material categories. With a few exceptions, material categories were evaluated using the processes included in the No Action Alternative (i.e., those processes included in the Solid Residue Environmental Assessment), one or more processes that do not include separation of plutonium from the material, one or more processes that include separation of plutonium from the material, and a combination of processes (as described in Alternative 4). Materials that were not evaluated for processes with plutonium separation were inorganic ash residues and certain sludge residues. Materials that were not considered for the combination of processing technologies were plutonium fluoride residues, Ful Flo filter media residues, and scrub alloy. Processing technologies that are applicable to each of the material categories and subcategories and DOE's preferred alternative are identified in Figure S-3. A brief overview of each of the technologies is presented in Figures S-4, S-5, S-6, and S-7. Figures S-8 through S-17 identify, for each material type, the paths from processing to ultimate disposition for the applicable processing technologies. Detailed descriptions of the processing technologies are contained in Chapter 2 and Appendix C of the Final EIS.

Figure S-3. Processing Technologies by Material Category

This figure should be reviewed in conjuction with Figures S-4 through S-17.

	Processing Technologies																											
	Alternative 1 NO ACTION (All Stabilizations Would Occur at Rocky Flats)							Alternative 2 PROCESS WITHOUT PLUTONIUM SEPARATION (All Processing Would Occur at Rocky Flats)						Alternative 3 PROCESS WITH PLUTONIUM SEPARATION										Alternative 4[b] Combination of Processing Technologies (All Processing Would Occur at Rocky Flats)				
MATERIAL CATEGORIES	Calcination/Cementation	Pyro-Oxidation	Neutralization/Dry	Thermal Desorption/Steam Passivation	Repackaging	Acid Dissolution/Plutonium Oxide Recovery	Filtration/Dry	Cementation	Calcination/Vitrification	Cold Ceramification	Blend Down	Catalytic Chemical Oxidation	Sonic Wash	Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats	Acid Dissolution/Plutonium Oxide Recovery at Los Alamos National Laboratory	Purex Process at the Savannah River Site	Mediated Electrochemical Oxidation at Rocky Flats	Mediated Electrochemical Oxidation at the Savannah River Site	Salt Distillation at Rocky Flats	Salt Distillation at Los Alamos National Laboratory	Salt Scrub at Rocky Flats and Purex Process at Savannah River Site	Water Leach at Rocky Flats	Water Leach at Los Alamos National Laboratory	Calcination/Cementation	Neutralization/Dry	Thermal Desorption/Steam Passivation	Repackaging	Filtration/Dry
ASH RESIDUES																												
Incinerator Ash Residues	●								●	●	●					●		●						●			■	
Sand, Slag, and Crucible Residues	●								●		●					■								●			●	
Graphite Fines Residues	●								●		●							●						●			■	
Inorganic Ash Residues	●								●		●													●			■	
PYROCHEMICAL SALT RESIDUES																												
MSE Salt Residues (IDC 409)		●									●								●	●	●	●					■	
MSE/ER Salt Residues (All Others)		●									●								●	●	●	●					■	
DOR Salt Residues (IDCs 365, 413, 417, 427)[a]		●									●				■						●	●	●				■	
DOR Salts (All Others)		●									●				●						●	●	●				■	
COMBUSTIBLE RESIDUES																												
Aqueous-Contaminated			●								●	●	●				●								■			
Organic-Contaminated				●							●	●	●				●									■		
Dry					●						●	●	●				●										■	
PLUTONIUM FLUORIDE RESIDUES						●					●			●		■												
FILTER MEDIA RESIDUES																												
Ful Flo Filters (IDC 331)			●								■		●				●											
HEPA Filters (IDC 338 only)			●						●		●		●				●								■			
HEPA Filters (All Others)			●						●		●		●				●										■	
SLUDGE RESIDUES																												
IDCs 089,099, and 332							●		●		●																■	
All Other Sludge Residues							●		●		●			●														■
GLASS RESIDUES			●						●		●		●				●								■			
GRAPHITE RESIDUES					●			●	●		●						●	●									■	
INORGANIC (Metal & Other) RESIDUES					●				●		●						●	●									■	
SCRUB ALLOY					●				●							■												

■ = Preferred processing option ● = Other processing options analyzed **Notes:** IDC = Item Description Code; MSE = molten salt extraction; ER = electrorefining; DOR = direct oxide reduction; HEPA = high-efficiency particulate air

[a] *There are two preferred processing technologies for processing high plutonium concentration DOR salt residues. The rationale for having two preferred processing technologies is given in Section 2.5 of this Summary.*

[b] *Alternative 4 may require blending high plutonium concentration materials with similar low plutonium concentration materials or with inert materials to achieve plutonium concentrations below 10 percent.*

Figure S-4. Processing Technologies for Alternative 1 — No Action (Stabilize and Store)

Calcination – To provide a more chemically stable form of ash residues, calcination involves heating the ash residues in a furnace at 500°C (930°F) to convert reactive metals, carbon, and organics to oxides. This step would be necessary to place ash residues into a form suitable for cementation and subsequent packaging and storage. It would also be a first step in preparing ash residues for processing without plutonium separation (vitrification) or for shipment to the Savannah River Site for processing with plutonium separation.

Cementation – An adaptation of the immobilization process widely used within DOE and the commercial industry and approved by the Environmental Protection Agency as a Best Demonstrated Available Technology for waste stabilization. After calcining the ash residues and crushing any oversize pieces (creating stabilized residue fines), the cementation process blends Portland cement and water with the ash residues, creating a solid material for packaging and storage.

Pyro-Oxidation – A process that converts reactive metals in salt residues to oxides for a more chemically stable waste form. Pyrochemical salt residues and an oxidant would be placed in a crucible and heated in a furnace to about 800°C (1,470°F). The result would be a stabilized, solidified salt form ready for packaging and storage. This process would also be a first step in preparing pyrochemical salt residues for processing without plutonium separation (e.g., blending down) or for processing with plutonium separation, if necessary.

Neutralization/Dry – A washing and drying process for combustible, filter media, and glass residues to remove nitrate contamination, neutralize any residual nitric acid and eliminate the potential flammability hazard. The residues would be washed in potassium hydroxide to convert the acid to potassium nitrate and water. Combustible solids would be separated from the nitrate solution, decanted, filtered, transferred to a drying pan, and dried under a vacuum at 80°C (176°F) for 2 hours. The result would be a neutralized dry solid ready for packaging and storage. The spent neutralization solution would go to the site's wastewater treatment process.

Thermal Desorption/Steam Passivation – A heating process that removes the organic solvent contaminants from combustible residues and converts plutonium fines in the residues to plutonium oxide. Batches of combustible residues would be heated to 80°C (176°F) for 2 hours under reduced pressure to volatilize the organic solvent contaminants. 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. Upon cooling, dry absorbent would be added to dry the wet matrix, and the result would be a shredded combustible waste and absorbent ready for packaging and storage.

Repackaging – The transferring of residues or scrub alloy into more sturdy containers. Under Alternative 1, this includes the direct repackaging of the dry combustible residues, graphite residues, inorganic residues, and scrub alloy that are presently in a physical or chemical form that requires repackaging, but no additional processing, to meet interim safe storage criteria. Repackaging would be conducted in gloveboxes and consists of unpacking the existing storage drums and the plastic bags inside the drums, sorting the residues, and repackaging them into metal containers. After packaging and nondestructive assay, the metal containers would be staged inside 208-liter (55-gallon) drums, for safe interim storage.

Acid Dissolution/Plutonium Oxide Recovery – Conducted in a glovebox, this process dissolves plutonium fluorides into a slurry, followed by precipitation and filtration of plutonium oxalate. That precipitate would be calcined and packaged as plutonium oxide. The filtrate from the oxalate precipitation is processed with magnesium hydroxide to precipitate the plutonium remaining in the solution. The magnesium hydroxide contaminated with plutonium would then be removed and calcined, resulting in a stabilized form for packaging and storage.

Filtration/Dry – A process used on sludge residues to remove any excess liquid and dry the remaining material by mixing with an absorbent. First, unwanted materials in the sludge (plastics, metals, or free liquids) would be removed and managed appropriately. After decanting, the sludge would be packed, along with absorbent for drying, into metal containers and sealed for packaging into pipe components and drums for storage.

Figure S-5. Processing Technologies for Alternative 2 — Processing without Plutonium Separation

Cementation – As a processing technology for graphite residues, this would be the same process used in Alternative 1 (No Action - Stabilize and Store) for ash residues. In this case, cementation would result in an acceptable waste form for WIPP disposal for graphite molds, scarfed graphite molds, coarse graphite, and coarse firebrick.

Calcination/Vitrification – An immobilization process similar in concept to calcination in which the residues would be heated in a furnace to produce a vitrified solid material. The process would be conducted in gloveboxes, where a siliceous material called "frit" would be added to the residues, and the material would be heated in a muffle furnace at temperatures between 700°C and 1,300°C (1,290°F - 2,370°F) for about 4 hours. The result would be a stable, glassified (vitrified) monolith that fits into an 8 x 10 inch metal can. This process could be applied to several categories of residues (ash, filter media, sludge, glass, graphite, and inorganic) and the scrub alloy. Scrub alloy would be first converted to an oxide by burning and calcining at 600°C (1,110°F) and 1,000°C (1,830°F), respectively. Then the calcined material would be blended with sufficient glass frit to make a product that would satisfy the safeguards termination limits, and heated in a furnace to a temperature of 700°C - 1,300°C (1,290°F - 2,370°F). The end product would consist of a vitrified monolith containing less than 5 percent plutonium.

Blend Down – A process for diluting the concentration of plutonium in all categories of plutonium residues (but not scrub alloy) so that each container would meet safeguards termination limits. An inert material, such as uranium oxide, salt, or magnesium oxide, would be added to create a mixture of materials with a smaller weight percentage of plutonium. Residues with a plutonium concentration below the safeguards termination limit may also be used. The dilution would initially create a larger waste mixture, which would then be reduced into smaller batches and calcined at 900°C (1,650°F). Calcination would eliminate water and oxidize any carbon or organic compounds into carbon dioxide.

Cold Ceramification – A process that stabilizes incinerator ash residues by converting them into chemically bonded phosphate ceramics. The process would result in an acceptable waste form for disposal at WIPP after repackaging.

Digestion (Catalytic Chemical Oxidation or Detox Process) – A process used to digest organic materials in combustible residues. The process uses catalysts, dissolved in acid, to oxidize organic materials and to dissolve metals associated with the residues. The metals, including plutonium, would be converted to metal oxides by boiling down the solution. The residual metal oxides would be placed in containers for storage pending disposal at the WIPP.

Sonic Wash – A process to physically separate plutonium from combustible, filter media, and glass residues using sound waves. The materials would be shredded, lowered into a sonic wash unit containing a weak caustic solution, and agitated by sound waves. The sonic agitation would dislodge a portion of the transuranic oxides and other higher-density materials from the surfaces of the matrix. The dislodged materials would settle to the bottom, and the washed matrix would be dried and repackaged for shipment to WIPP for disposal. The settled transuranic-laden materials or sludges would be filtered from the wash, dried and stored until they could be batched for immobilization (vitrification for combustible and filter media residues and calcining for glass residues). The immobilized settlings would be packaged for ultimate disposal. The effluent streams from the filtration and rinsing steps would be evaporated and recycled back to the sonic wash unit.

Figure S-6. Processing Technologies for Alternative 3 — Processing with Plutonium Separation

Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats – A process to recover plutonium from plutonium fluoride residues and sludge residues by dissolving them in nitric acid and precipitating the plutonium with oxalic acid. The resulting plutonium oxalate slurry would be filtered to separate plutonium oxalate and a filtrate. Magnesium hydroxide would be added to the filtrate to precipitate any remaining plutonium. The magnesium hydroxide would be filtered, calcined at 450°C (840°F), and packaged for interim storage and ultimate disposal at WIPP. The plutonium oxalate filter cake would be calcined at 450°C (840°F) until it results in a dry plutonium oxide cake, which would be packaged and temporarily stored until it could be calcined at 1,000°C (1,830°F) to remove volatile constituents. The recalcined plutonium oxide would then be repackaged to meet DOE standards for interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement.

Acid Dissolution/Plutonium Oxide Recovery at Los Alamos National Laboratory – A process to recover plutonium from direct oxide reduction salt residues. The residue would be first dissolved in concentrated hydrochloric acid and then the plutonium and americium would be separated from the salt matrix by solvent extraction using tributylphosphate in dodecane. After separation of the aqueous and organic layers, the organic phase would be stripped of plutonium using dilute hydrochloric acid and the aqueous phase would be stored pending further processing. Addition of oxalic acid to the plutonium-bearing solution would cause plutonium to precipitate as plutonium oxalate. The resulting plutonium oxalate slurry would be filtered and calcined at 400°C (750°F) to decompose plutonium oxalate to plutonium oxide, which would be packaged and temporarily stored until it could be calcined at 1,000°C (1,830°F) to remove volatile constituents. The recalcined plutonium oxide would then be repackaged to meet DOE standards for interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement. Magnesium hydroxide would be added to the filtrate from oxalate precipitation and the aqueous phase from solvent extraction to precipitate any remaining plutonium in those solutions. This material would be filtered, calcined at 450°C (840°F), packaged, and stored for shipment to WIPP as transuranic waste.

Purex Process/Plutonium Metal or Oxide Recovery – A process developed for plutonium extraction and recovery. It would use a Canyon facility at the Savannah River Site to process ash residues (except for graphite fines and inorganic ash), plutonium fluoride, and scrub alloy. These materials would be dissolved in nitric acid and separated into a waste fraction and a plutonium-bearing fraction. The waste fraction would be added to the Site's high-level waste storage system, where solids would be vitrified with other high-level wastes at the Defense Waste Processing Facility, and residual liquids would be solidified as saltstone. The plutonium-bearing fraction would be transferred to a finishing line (FB/HB), precipitated and converted to stable oxide or metal, and packaged to meet DOE standards for interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement.

Mediated Electrochemical Oxidation – Similar to the Purex and acid dissolution/plutonium oxide recovery processes described above, but would also use oxidized silver ions generated in an electrochemical cell to catalyze the dissolution of normally unreactive plutonium compounds. Undissolved materials remaining after mediated electrochemical oxidation processing would be removed by filtration, dried, and packaged for shipment to WIPP for disposal as transuranic wastes. Plutonium dissolved in the nitric acid/silver nitrate solution would be processed differently, however, depending on the nature of the materials and the facilities available for processing it.

Plutonium from mediated electrochemical oxidation dissolution of graphite and inorganic residues at the Savannah River Site and from mediated electrochemical oxidation processing of all ash residues would be processed through the Purex system. Here the plutonium would be reduced to metallic or oxide form and packaged to meet DOE standards for interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement. Plutonium-bearing solutions from mediated electrochemical oxidation-treated glass and inorganic residues at Rocky Flats, as well as from mediated electrochemical oxidation-treated combustible waste, filter media, and graphite residues, would be treated with oxalic acid to precipitate the plutonium as an oxalate. This oxalate would then be calcined, recalcined, and packaged for long-term storage using the same plutonium oxide recovery process described above under the acid dissolution alternative.

Salt Distillation – A process that separates transuranic materials from a potassium chloride or sodium chloride salt matrix by using a special furnace to distill these salts away from any metal oxides in the matrix. The salt matrix would first be pyro-oxidized, as described in Alternative 1 (No Action - Stabilize and Store), and then heated under vacuum in the distillation furnace to about 950°C (1,740°F) for about 6 hours. The distilled salts would be stored for ultimate disposition at WIPP. The metal oxides and undistilled salts, such as calcium chloride, would be calcined at 1,000°C (1,830°F) for 4 hours and packaged for interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement. Salt distillation would be used only for salt residues from pyrochemical processing, such as electrorefining and molten salt extraction.

(continued)

Figure S-6. Processing Technologies for Alternative 3 — Processing with Plutonium Separation (continued)

Salt Scrub – A process that recovers plutonium from salt residues by heating them in a crucible with magnesium and aluminum, or gallium and calcium, inside a glovebox furnace. The magnesium or calcium would reduce any plutonium and americium chlorides in these residues to metallic form, allowing the metals to be extracted in an alloy with the aluminum or gallium. Heated to 800°C (1,470°F) for 2 hours, this alloy (called scrub alloy) would separate from the salts and form a metallic button at the bottom of the crucible. After cooling, the scrub alloy button would be sent to the Savannah River Site for Purex processing, as described above, to reduce the plutonium to metal or oxide, and packaged to meet DOE standards for interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement. The residual salts removed from the crucible would be batched to meet safeguards termination limits and pyro-oxidized as described above to stabilize any reactive metals before packaging and shipment to WIPP for disposal. Salt scrubbing would remove plutonium from calcium chloride, as well as sodium chloride/potassium residues.

Water Leach – A dissolution process to recover plutonium from pyrochemical salts using water leach. The salt would be first pyro-oxidized, if necessary, as discussed under Alternative 1 (No Action - Stabilize and Store), then placed in a leaching vessel with water added. Because the pyro-oxidation process produces an excess of sodium oxide, the resulting solution would be alkaline. The alkaline slurry would then be vacuum-filtered, leaving a damp solid filter cake of plutonium/americium oxide, which would then be calcined at 1,000°C (1,830°F) for 4 hours to remove any remaining volatile materials. The oxide material would be packaged for interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement. The filtrate would be evaporated, leaving a lean salt that would be packaged according to WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

Figure S-7. Processing Technologies for Alternative 4 — Combination of Processing Technologies[a]

Calcination – To provide a more chemically stable form of ash residues, calcination involves heating the ash residues in a furnace at 500°C (930°F) to convert reactive metals, carbon, and organics to oxides. This step would be necessary to place ash residues into a form suitable for cementation and subsequent packaging and shipment to WIPP.

Cementation – An adaptation of the immobilization process widely used within DOE and the commercial industry and approved by the Environmental Protection Agency as a Best Demonstrated Available Technology for waste stabilization. After calcining the ash residues and crushing any oversize pieces (creating stabilized residue fines), the cementation process blends Portland cement and water with the ash residues, creating a solid material for packaging and shipment to WIPP.

Neutralization/Dry – A washing and drying process for combustible, filter media, and glass residues to remove nitrate contamination, neutralize any residual nitric acid and eliminate the potential flammability hazard. The residues would be washed in potassium hydroxide to convert the acid to potassium nitrate and water. Combustible solids would be separated from the nitrate solution, decanted, filtered, transferred to a drying pan, and dried under a vacuum at 80°C (176°F) for 2 hours. The result would be a neutralized dry solid ready for packaging and shipment to WIPP. The spent neutralization solution would go through the site's wastewater treatment process.

Thermal Desorption/Steam Passivation – A heating process that removes the organic solvent contaminants from combustible residues and converts plutonium fines in the residues to plutonium oxide. Batches of combustible residues would be heated to 80°C (176°F) for 2 hours under reduced pressure to volatilize the organic solvent contaminants. 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. Upon cooling, dry absorbent would be added to dry the wet matrix, and the result would be a shredded combustible waste and absorbent ready for packaging and shipment to WIPP.

Repackaging – The transferring of residues into more sturdy containers. Under Alternative 4, this includes, if necessary, the combining of above-10-percent-plutonium material with below-10-percent-plutonium material or inert material to reach a mixture containing no higher than 10 percent plutonium and subsequent repackaging of the ash, pyrochemical salts, combustibles, filter media, sludges, graphite, and inorganics, with no additional processing, to meet shipping requirements for WIPP disposal. Pyrochemical salts will be pyro-oxidized (as necessary) prior to blending. Blending and repackaging would be conducted in gloveboxes and consist of unpacking the existing storage containers, sorting and combining the residues, one waste stream at a time, as described above, and repackaging them either in metal containers or plastic bags, as appropriate. After packaging and non-destructive assay, the metal containers would be placed inside pipe components (with the exception of certain residues, such as combustibles) and loaded into drums. The plastic bags would be loaded into drums and then non-destructively assayed. Both sets of drums would then be ready for shipment to WIPP.

Filtration/Dry – A process used on sludge residues to remove any excess liquid and dry the remaining material by mixing with an absorbent. First, unwanted materials in the sludge (plastics, metals, or free liquids) would be removed and managed appropriately. After decanting, the sludge would be packed, along with absorbent for drying, into metal containers and sealed for packaging into pipe components and drums for shipment to WIPP.

[a] *In order to receive a variance to safeguards termination limits, materials would be blended down, as necessary, to reduce their plutonium concentrations to less than 10 percent.*

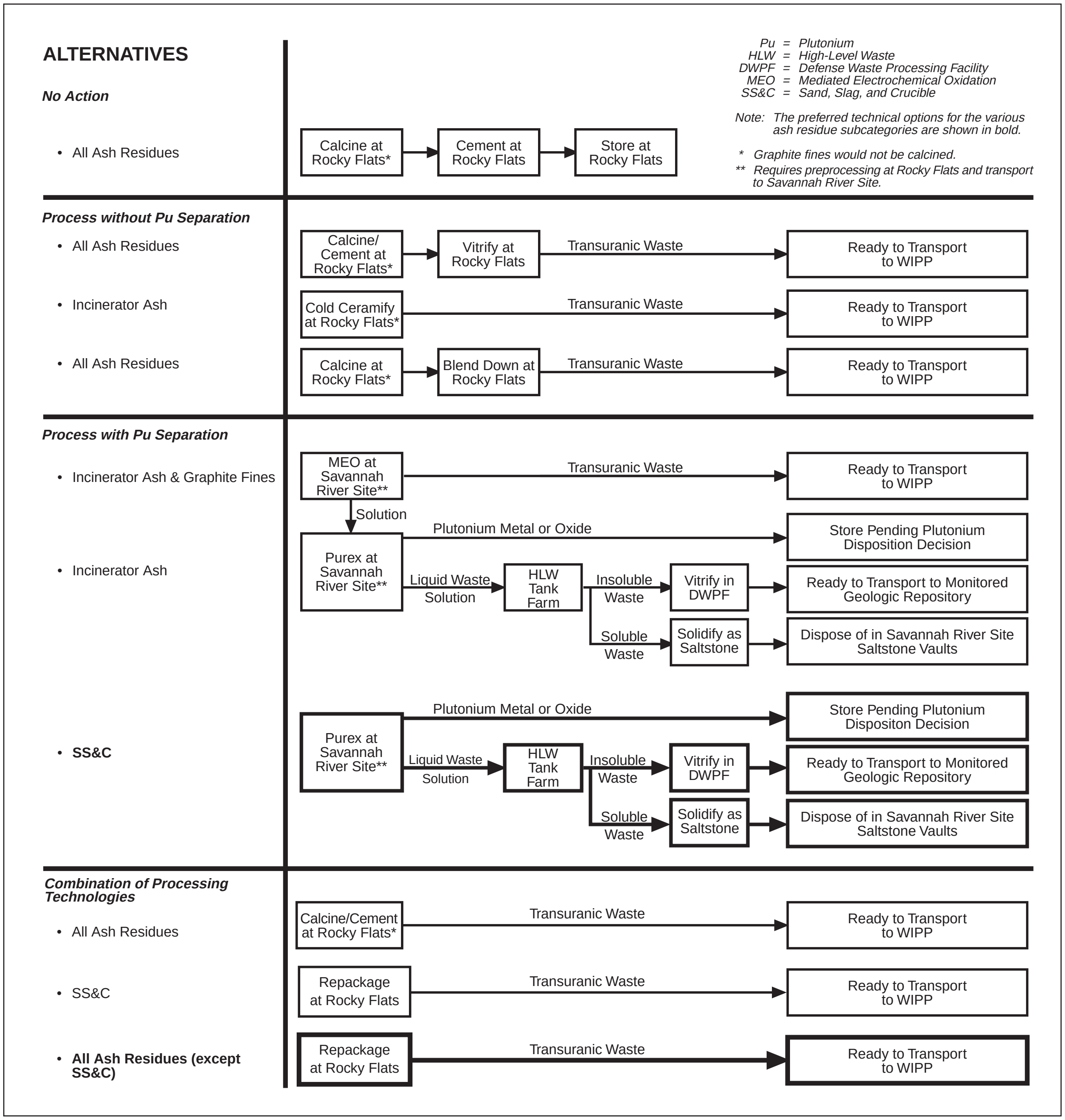


Figure S-8. Processing Technologies for Ash Residues

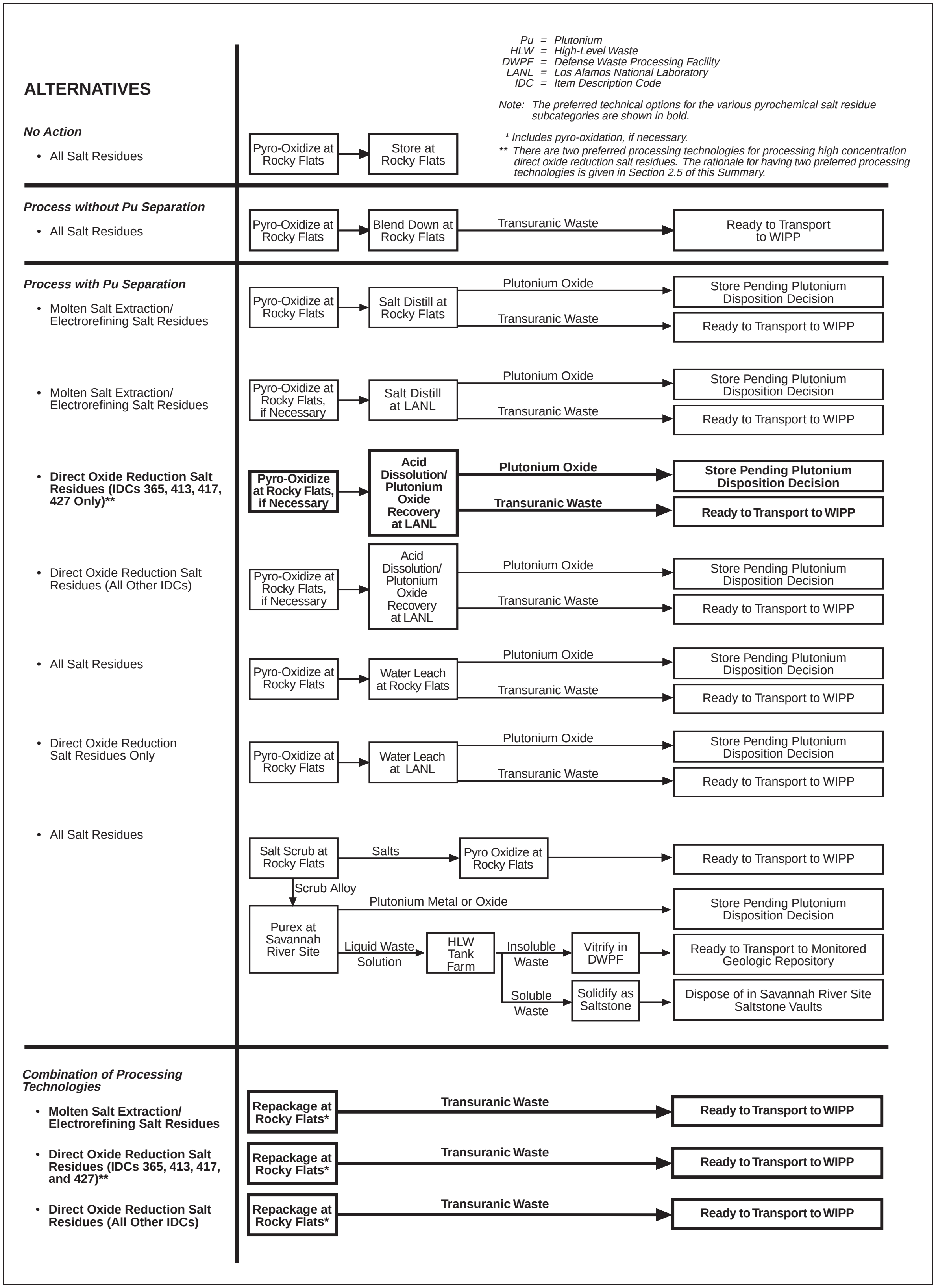


Figure S-9. Processing Technologies for Pyrochemical Salt Residues

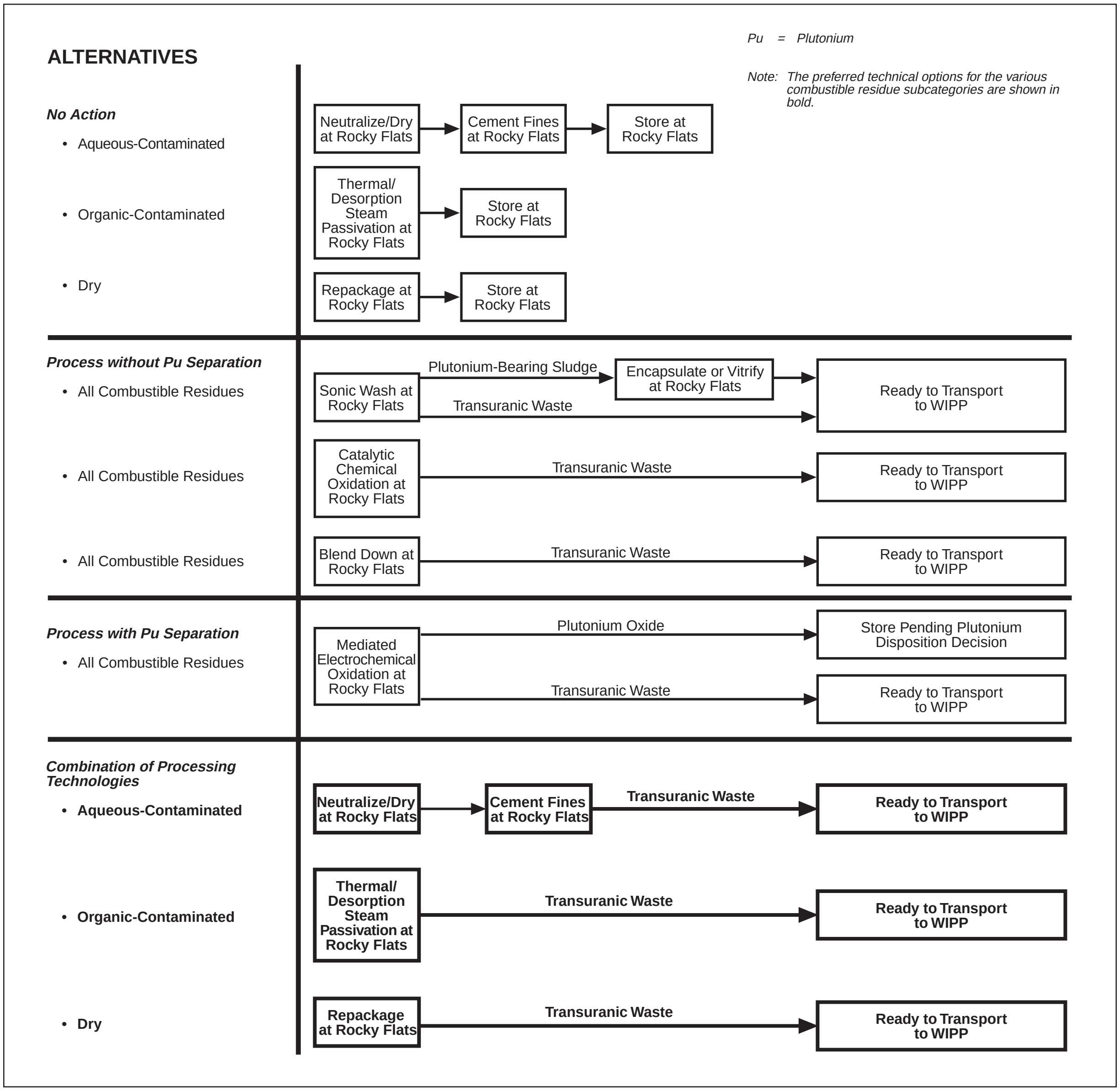


Figure S-10. Processing Technologies for Combustible Residues

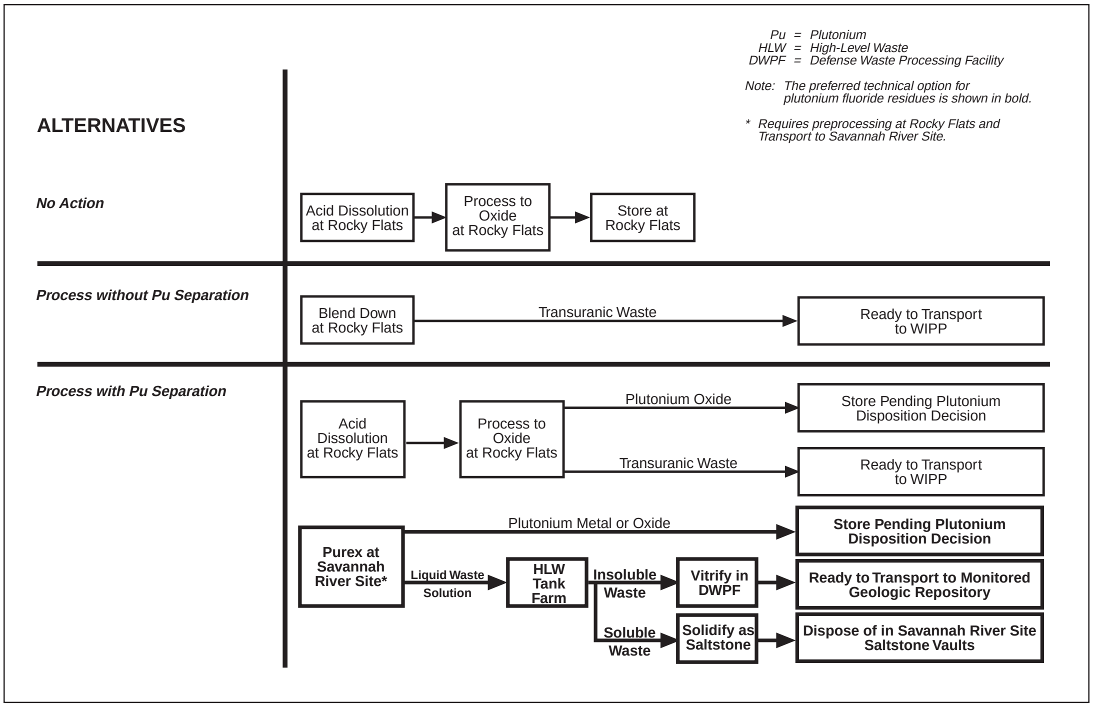


Figure S-11. Processing Technologies for Plutonium Fluoride Residues

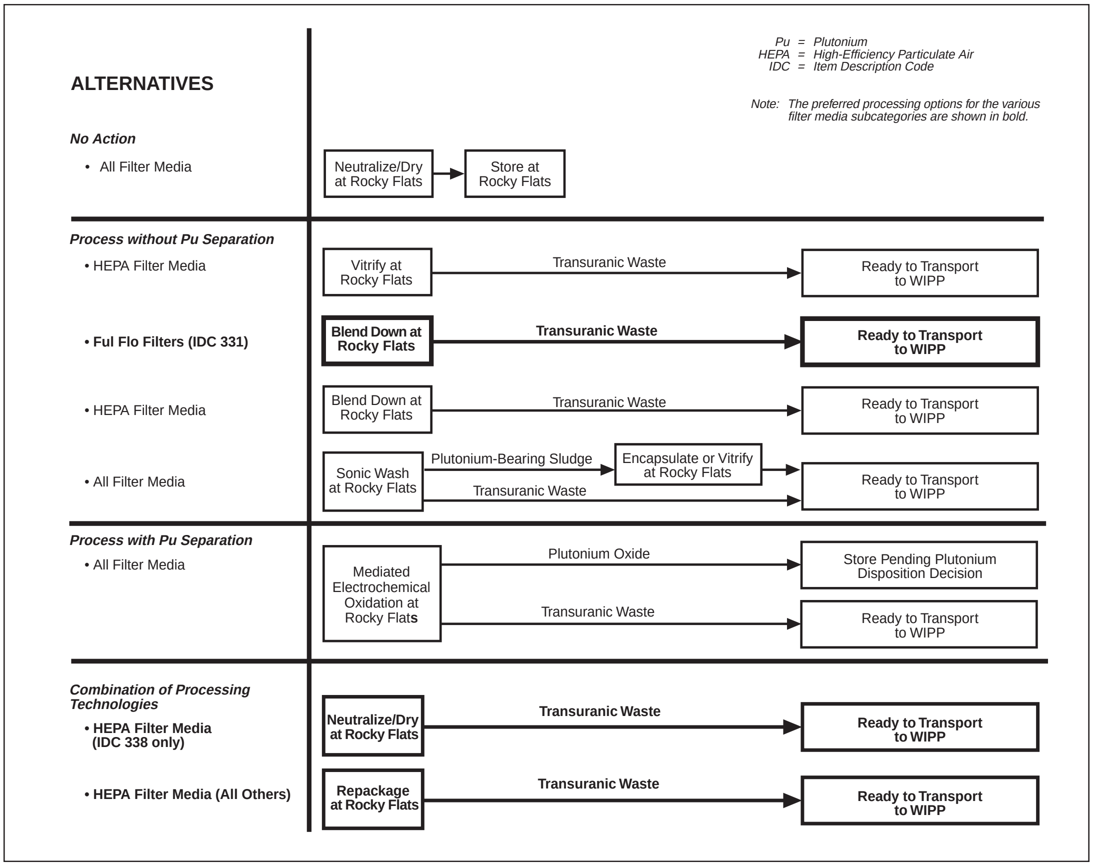


Figure S-12. Processing Technologies for Filter Media Residues

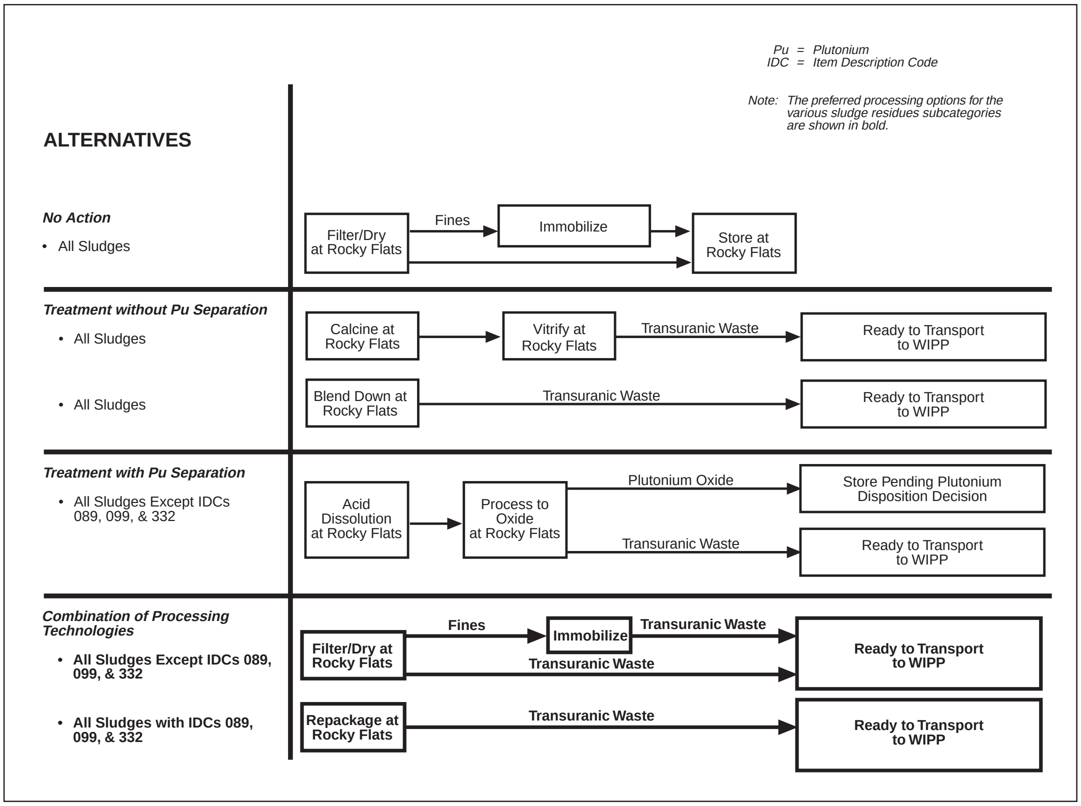


Figure S-13. Processing Technologies for Sludge Residues

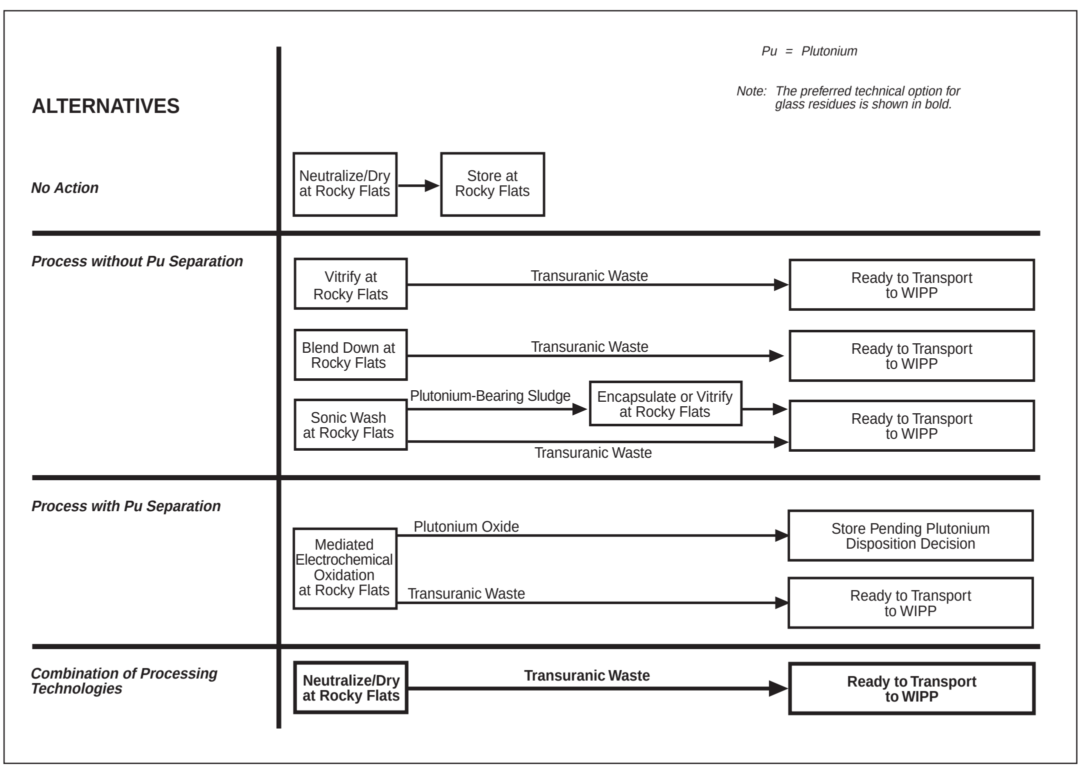


Figure S-14. Processing Technologies for Glass Residues

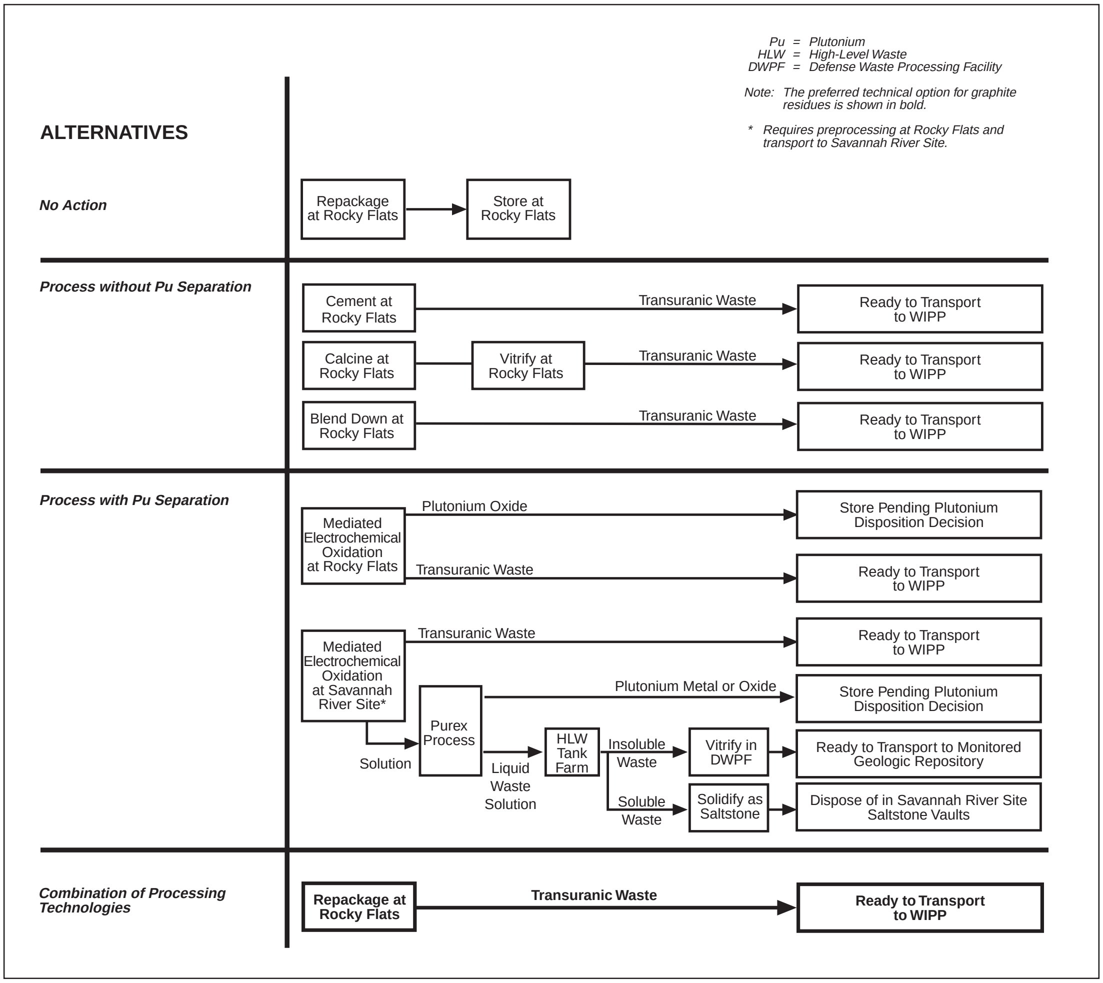


Figure S-15. Processing Technologies for Graphite Residues

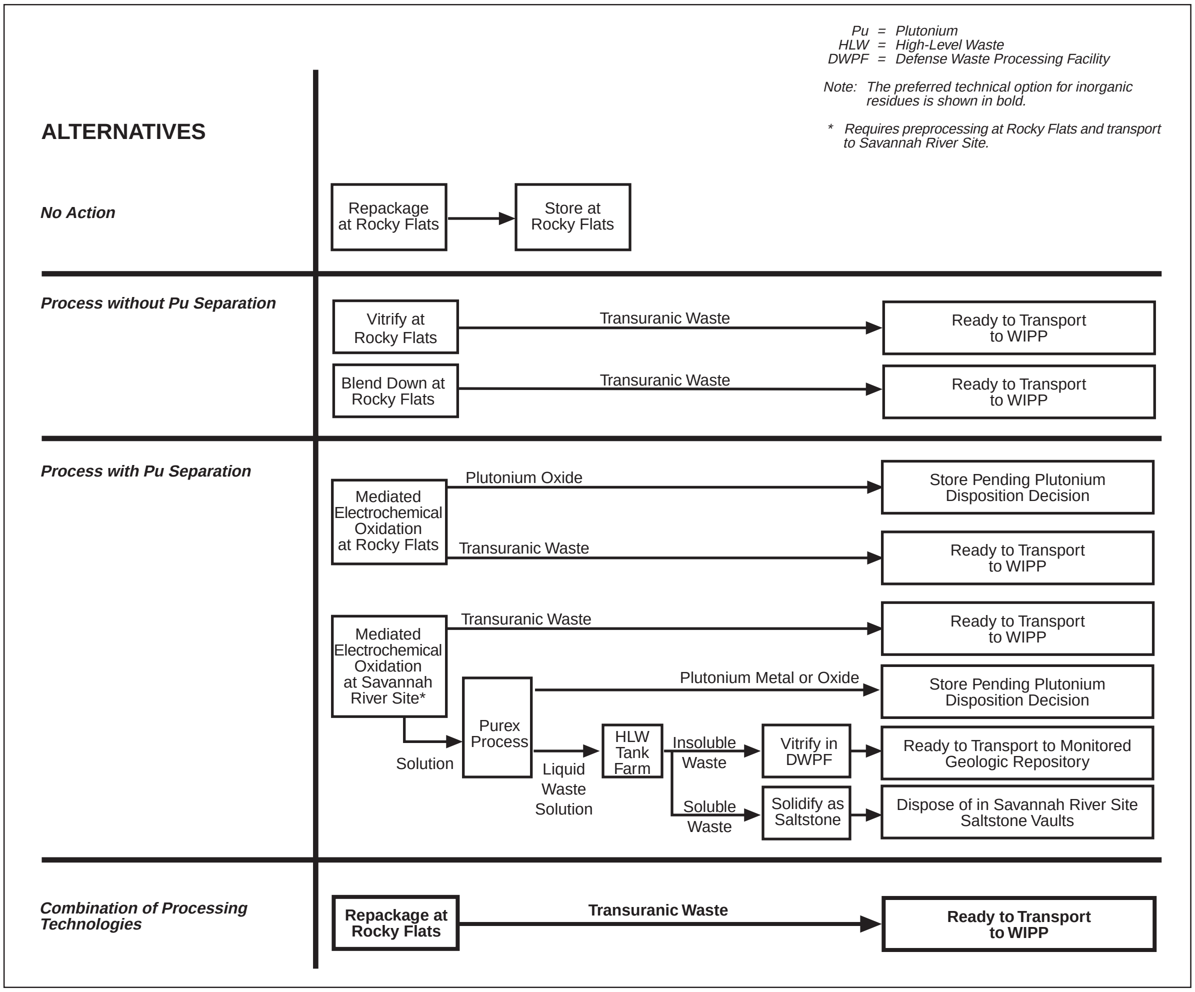


Figure S-16. Processing Technologies for Inorganic Residues

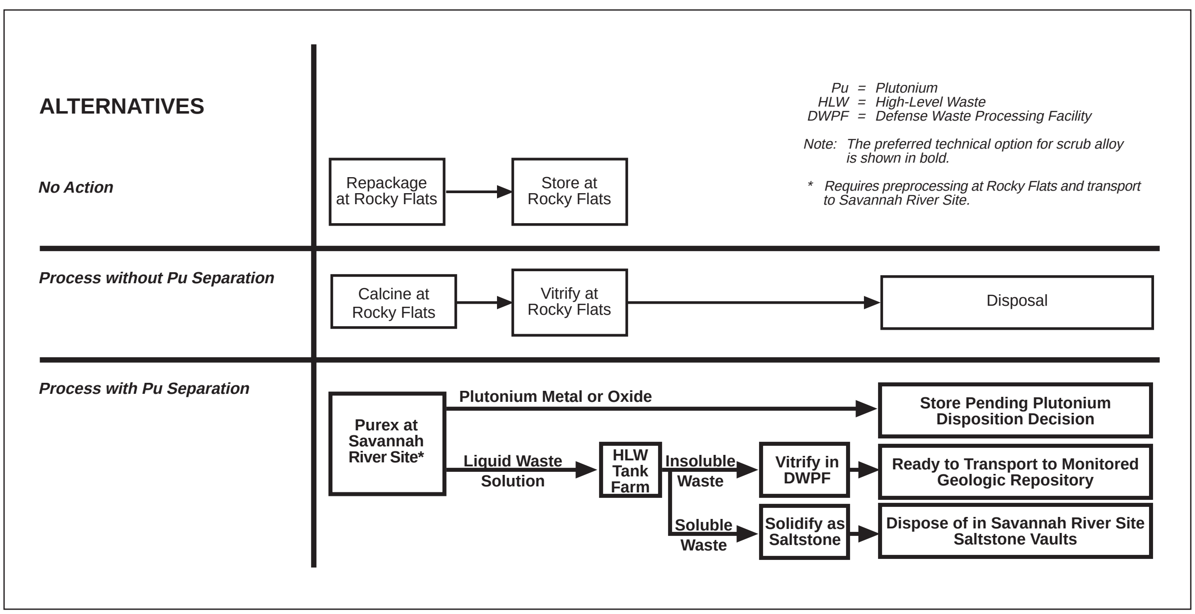


Figure S-17. Processing Technologies for Scrub Alloy

2.5 PREFERRED ALTERNATIVE

DOE has identified a preferred technology/site option for processing each category of Rocky Flats plutonium residues and the scrub alloy addressed in this EIS. The material categories and preferred processing technologies are listed in Table S-4. Taken as a group, the compilation of the preferred technology/site processing technologies constitutes the Preferred Alternative for this EIS. The detailed rationale for selecting each of the preferred technologies is provided in Section 2.4 of the Final EIS.

Under the Preferred Alternative, all materials would be processed at Rocky Flats except for sand, slag, and crucible; certain direct oxide reduction salts; fluoride residues; and scrub alloy. The salts would be processed at Los Alamos National Laboratory (up to 727 kg [1,603 lb] of bulk, containing 139 kg [306 lb] of plutonium). The other materials would be processed at the Savannah River Site (4,077 kg [8,988 lb] of bulk containing 470 kg [1,036 lb] of plutonium).

As shown in Table S-4, 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 preferred not only because they would 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 F-Canyon, FB-Line, H-Canyon, and the HB-Line. Use of these facilities, some of which are designed for remote operation, would result in lower worker radiation exposure than use of the glove box 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 periods of exposure to the residues than would the nonseparation technology.

Also as shown in Table S-4, there are two preferred processing technologies for the direct oxide reduction salt residues with Item Description Codes (IDCs) 365, 413, 417, and 427. This is because these IDCs contain salt residues with high concentrations of plutonium and others with lower plutonium concentrations. The two preferred processing technologies for these IDCs are: (1) preprocessing at Rocky Flats followed by acid dissolution/plutonium oxide recovery at the Los Alamos National Laboratory for the high plutonium concentration salts and (2) pyro-oxidation (if necessary) followed by repackaging (with blending, if necessary) at Rocky Flats for the remaining salts in these IDCs.

DOE believes that there are only about 306 kg (675 lb) of high plutonium concentration salt residues from IDCs 365, 413, 417, and 427 that would need to be processed at Los Alamos National Laboratory. Material that would need to be processed at Los Alamos National Laboratory would include material that was not granular or would not easily be finely ground (e.g., material in solid clumps). There is the possibility that additional material beyond the 306 kg might be identified upon physical inspection of the containers, and a small quantity of additional material could also come from other direct oxide reduction salt IDCs. Given this uncertainty, DOE has analyzed the environmental impacts of processing up to 727 kg (1,603 lb) of direct oxide reduction salts at the Los Alamos National Laboratory using the acid dissolution/plutonium oxide recovery process. After processing, the plutonium oxides would be stored at Los Alamos National Laboratory in accordance with the Record of Decision that was issued after completion of the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* until it would be disposed of in accordance with decisions to be made after completion of the *Surplus Plutonium Disposition Environmental Impact Statement*. The transuranic waste generated during processing would be shipped to WIPP for disposal.

Direct oxide reduction salts 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 processed at Rocky Flats using pyro-oxidation/repackaging and prepared for shipment to WIPP for disposal.

Table S-4. Preferred Processing Technology for Each Material Category

MATERIAL	PREFERRED PROCESSING TECHNOLOGY
ASH RESIDUES	
Incinerator Ash Residues	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.1 of the EIS)
Sand, Slag, and Crucible Residues	Purex Process at the Savannah River Site under Alternative 3 (See Section 2.4.1 of the EIS)
Graphite Fines Residues	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.1 of the EIS)
Inorganic Ash Residues	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.1 of the EIS)
PYROCHEMICAL SALT RESIDUES	
Molten Salt Extraction/Electrorefining (IDC 409)	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.2 of the EIS)
Molten Salt Extraction/Electrorefining (all others)	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.2 of the EIS)
Direct Oxide Reduction Salt Residues (IDCs 365, 413, 417, and 427)[a]	Repackage at Rocky Flats under Alternative 4 and Acid Dissolution/Plutonium Oxide Recovery at Los Alamos National Laboratory under Alternative 3 (See Section 2.4.2 of the EIS)
Direct Oxide Reduction Salts (all others)	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.2 of the EIS)
COMBUSTIBLE RESIDUES	
Aqueous-Contaminated	Neutralize/Dry at Rocky Flats under Alternative 4 (See Section 2.4.3 of the EIS)
Organic-Contaminated (See Section 2.4.3 of the EIS)	Thermal Desorption/Steam Passivation at Rocky Flats under Alternative 4
Dry	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.3 of the EIS)
PLUTONIUM FLUORIDE RESIDUES	Purex Process at the Savannah River Site under Alternative 3 (See Section 2.4.4 of the EIS)
FILTER MEDIA RESIDUES	
Ful Flo Filter (IDC 331)	Blend Down at Rocky Flats under Alternative 2 (See Section 2.4.5 of the EIS)
HEPA Filters (IDC 338 only)	Neutralize/Dry at Rocky Flats under Alternative 4 (See Section 2.4.5 of the EIS)
HEPA Filters (all others)	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.5 of the EIS)
SLUDGE RESIDUES	
IDCs 089, 099, and 332	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.6 of the EIS)
All Other Sludge Residues	Filter/Dry at Rocky Flats under Alternative 4 (See Section 2.4.6 of the EIS)
GLASS RESIDUES	Neutralize/Dry at Rocky Flats under Alternative 4 (See Section 2.4.7 of the EIS)
GRAPHITE RESIDUES	Repackage at Rocky Flats under Alternative 4 (See Section 2.4.8 of the EIS)
INORGANIC (Metal & Other) RESIDUES	Repackaging at Rocky Flats under Alternative 4 (See Section 2.4.9 of the EIS)
SCRUB ALLOY	Purex Process at the Savannah River Site under Alternative 3 (See Section 2.4.10 of the EIS)

[a] *There are two preferred processing technologies for processing these 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 the text of this section.*

2.6 STORAGE METHODS

This EIS discusses storage of two categories of materials: (1) plutonium residues and scrub alloy and (2) plutonium metal and oxides. The storage methods for these materials are described below.

2.6.1 Storage of Plutonium Residues and Scrub Alloy

Plutonium residues and scrub alloy are stored in accordance with DOE guidance contained in *Criteria for Interim Safe Storage of Plutonium-Bearing Solid Material.* This guidance is included as an addendum to the DOE Implementation Plan for the Defense Nuclear Facilities Safety Board's Recommendation 94-1, dated February 28, 1995, which addresses remediation in the defense nuclear facilities complex.

Processed residues and scrub alloy, containing less than 50 percent plutonium by weight, are packaged in storage containers that provide multiple barriers. While in the glovebox, the material is placed into "produce cans," which are small sealed cans similar to those used for storage of food products. The "produce cans" are then sealed inside plastic "bagout bags" as they are removed from the glovebox. The next layer of containment is the "pipe component" (with the exception of certain residues such as combustibles), which is a flanged stainless-steel pipe measuring 15 - 30 centimeters (6 - 12 inches) in diameter. A lid bolted to the flange allows the residue material to be sealed within the pipe, which is then placed inside a 208-liter (55-gallon) storage drum. (See figure below.) Processes from Alternatives 2, 3, and 4 would produce stabilized residues and transuranic waste that may be packaged in this way. When ready for transport to WIPP, the drums would then be placed into the TRUPACT-II container, which is the Nuclear Regulatory Commission-certified and Department of Transportation-approved shipping container. (Section 2.8.1 of the Final EIS provides more details.) The TRUPACT-II loading limit for transport to WIPP is 2,800 fissile gram equivalents of plutonium-239.

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 packagings. Prior to shipment offsite, the double-contained packages would be placed into shielded containers authorized by DOE and the Department of Transportation for shipment. (See Section 2.8 of this Summary.)

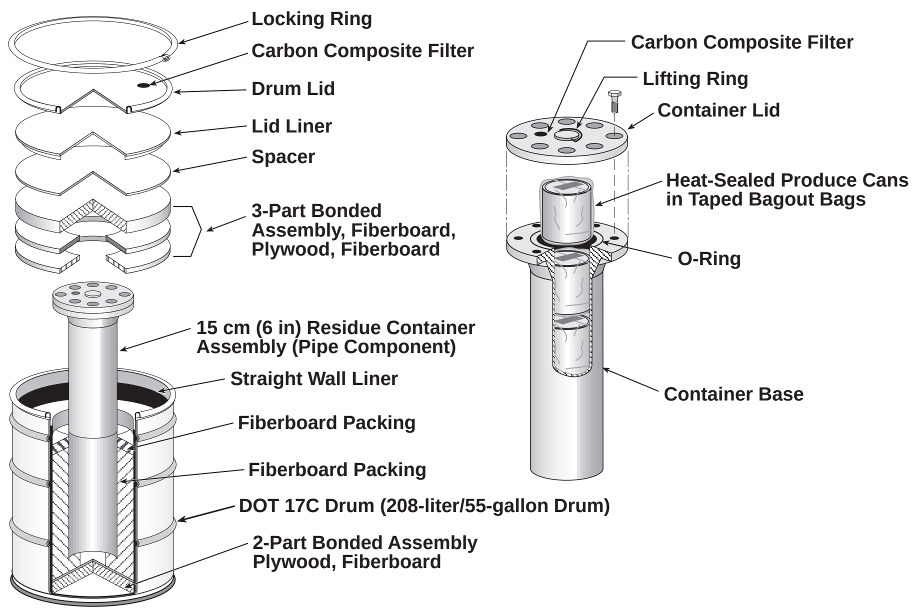
2.6.2 Storage of Plutonium Metal and Oxides

Processing the residues and scrub alloy under Alternative 3 would result in stabilized plutonium metal or oxide, which would be placed into safe and secure storage pending disposition in accordance with decisions to be reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement and the Surplus Plutonium Disposition Environmental Impact Statement.

Safe long-term storage of plutonium metal and oxide is addressed by DOE-STD-3013-96, *DOE Standard: Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage* (September 1996). This standard establishes criteria for packaging plutonium metals and stabilized plutonium oxides to ensure safe storage for at least 50 years. The standard applies to packaging for 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 handling accidents.

To ensure safe storage conditions, DOE has issued guidance that plutonium should not be stored in the form of plutonium solutions, metal turnings, or particles with a specific surface area greater than one square centimeter per gram. Plutonium metal items should be free of hazardous or pyrophoric materials or corrosion products. Plutonium oxides should be stabilized at 1,000°C (1,830°F) for 1 hour. In packaging, no plastic should contact plutonium metal or oxide, and metal should be packaged in as dry and inert an atmosphere as possible. Existing metal packages should be inspected for external corrosion, and packages containing more than 0.5 kg (1.1 lb) plutonium metal should be weighed annually.

Department of Transportation 17C Drum with 15 cm (6 in) Residue Container



2.7 DISPOSAL OR OTHER DISPOSITION

This section provides an overview of the disposition paths for the processed residues and scrub alloy covered by this EIS and for any separated plutonium that would occur under Alternative 3. The impacts of disposition are evaluated in other EISs that address the disposal of transuranic waste at WIPP and disposition of surplus plutonium and, thus, are not evaluated in this EIS. However, disposal in WIPP of scrub alloy (from which the plutonium has not been separated) would require additional NEPA review because the transuranic waste generated during its processing was not analyzed in the WIPP Disposal Phase Final Supplemental EIS. Such disposal may also require changes to current legal limitations on WIPP.

Under the No Action Alternative, no material would be prepared sufficiently to allow its disposition, as discussed in more detail in Section 1 of this Summary. Under the other alternatives, materials processing would result in transuranic waste that could be transported to WIPP for disposal. The environmental impacts of shipping transuranic waste to WIPP and the impacts of disposal at that site are covered in the *Waste Isolation Pilot Plant Disposal Phase, Final Supplemental Environmental Impact Statement* (DOE/EIS-0026-S-2, September 1997). Transportation impacts are summarized and are incorporated by reference in this EIS (see Appendix E, Section E.6.1).

Alternative 3 (Process with Plutonium Separation) analyzes processing that separates the plutonium from the waste material and concentrates it so residual material meets the safeguards termination limits for disposal at WIPP, while the separated and concentrated plutonium is placed in safe and secure storage pending ultimate disposition. In the Record of Decision for the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE/EIS-0229) described in Section 1.5.6 of the Final EIS, DOE decided to pursue a twofold strategy for disposition of surplus weapons usable plutonium: (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, described in Section 1.5.7 of the Final EIS, 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.

During the process to separate plutonium, some low-level waste and other material managed as high-level waste may be produced. These wastes would be managed according to the waste management practices for these waste types at the processing site.

2.8 TRANSPORTATION FOR OFFSITE PROCESSING

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.

The number of inter-site shipments that could potentially be sent to the Savannah River Site or Los Alamos National Laboratory under Alternative 3 for each processing technology is shown in Table S-5. 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 is given for both processes. In addition, processing of direct oxide reduction salts may result in shipments to Los Alamos National Laboratory (as residues) or to the Savannah River Site (as scrub alloy, following salt scrub at Rocky Flats). Table S-5 also shows the number of shipments under the Preferred Alternative. Under the Preferred Alternative, Rocky Flats would make only 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).

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.

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. DOE is also evaluating the possible use of a commercial transportation system for transporting a portion of these materials. The analyses in this EIS are based on a set of assumptions that conservatively bound the impacts that would result from use of either the Transportation Safeguards System or commercial carriers. Experience has shown that typical radiation levels for these shipments are below regulatory limits. This is due to several factors: (1) most of the radiation emitted from plutonium is alpha radiation, which cannot penetrate the container walls; (2) plutonium residues would be preprocessed/repackaged prior to shipment, and (3) the transport system, which includes containers, transportation packaging, and special transporter, provides multiple layers of containment.

Four aspects of ground transportation are discussed in the following sections: (1) transportation packaging system, (2) the "Safe Secure Trailer" system, (3) route selection process for offsite shipments, and (4) emergency management considerations.

Table S-5. Number of Inter-Site Shipments Under Alternative 3 and Under the Preferred Alternative

MATERIAL CATEGORY	PROCESS/SITE	POTENTIAL SHIPMENTS UNDER ALTERNATIVE 3	SHIPMENTS UNDER THE PREFERRED ALTERNATIVE
Incinerator Ash and Firebrick Fines* Residues	Purex at Savannah River Site Mediated Electrochemical Oxidation at Savannah River Site	116 86	0 0
Sand, Slag, and Crucible Residues	Purex at Savannah River Site	26	26
Graphite Fines Residues	Mediated Electrochemical Oxidation at Savannah River Site	7	0
Molten Salt Extraction/ Electrorefining Salt Residues	Salt Distillation at LANL - IDC 409 Salt Distillation at LANL - All Other IDCs Purex at Savannah River Site (following scrub) - IDC 409 Purex at Savannah River Site (following scrub) - All Other IDCs	6 44 7 15	0 0 0 0
Direct Oxide Reduction Salt Residues	Acid Dissolution or Water Leach at LANL - IDCs 365, 413, 417, and 427 Acid Dissolution or Water Leach at LANL - All Other IDCs Purex at Savannah River Site (following scrub) - IDCs 365, 413, 417, and 427 Purex at Savannah River Site (following scrub) - All Other IDCs	3 10 3 1	3 0 0 0
Combustible Residues	Not Shipped	0	0
Plutonium Fluoride Residues	Purex at Savannah River Site	7	7
Filter Media Residues	Not Shipped	0	0
Sludge Residues	Not Shipped	0	0
Glass Residues	Not Shipped	0	0
Graphite Residues	Mediated Electrochemical Oxidation at Savannah River Site	16	0
Inorganic (Metal and Others) Residues	Mediated Electrochemical Oxidation at Savannah River Site	4	0
Existing Scrub Alloy	Purex at Savannah River Site	6	6

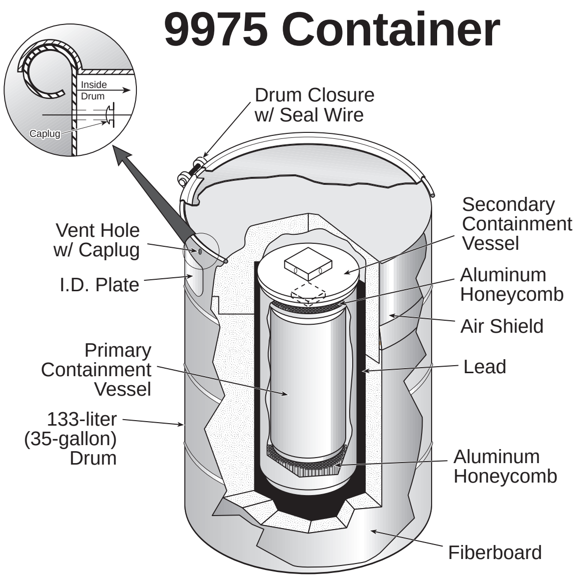
* Firebrick fines would not be processed by the Purex process
LANL = Los Alamos National Laboratory
IDC = Item Description Code

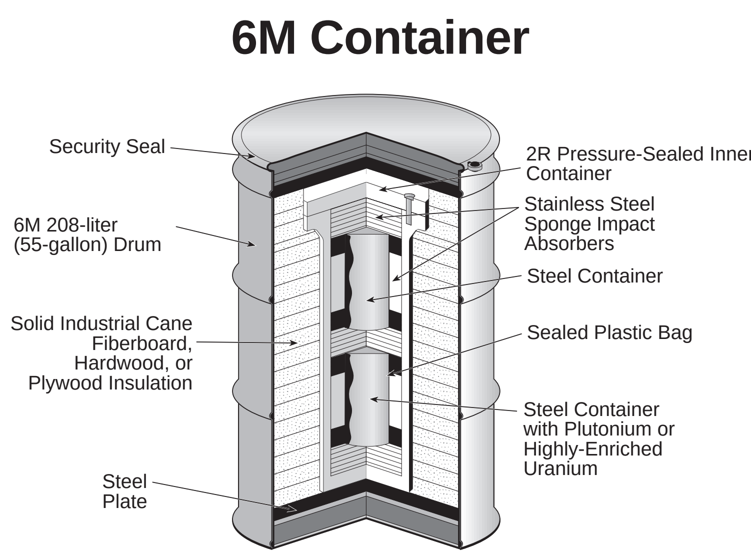
2.8.1 TRANSPORTATION PACKAGING

The containers that would be used by DOE for shipping residues and scrub alloy for offsite processing are authorized or certified by the Department of Transportation, the Department of Energy, or the Nuclear Regulatory Commission. They are known by regulation as "Type B" packaging. In general, scrub alloy and plutonium-bearing residues would be shipped in packaging such as 9968, 9975, or 6M containers (see the schematic diagrams). Two typical Type B designs that would be used for shipments under this EIS are illustrated below.

Type B packaging is made up of several components and is designed to reduce the risk of material dispersal, radiation exposure, or criticality. In addition to meeting Nuclear Regulatory Commission-specified standards demonstrating it can withstand normal conditions of transport without loss or dispersal of its radioactive contents, the Type B container used for DOE shipments must also be designed to survive certain severe hypothetical accident conditions that demonstrate by testing or analysis resistance to impact, puncture, fire, and water submersion. These hypothetical accident conditions do not duplicate accident environments but, rather, are defined so that they produce damage equivalent to extreme and unlikely accidents. The sequence of tests is described in more detail in Appendix E of the EIS. The Type B designs considered in this EIS have been tested under normal and accident conditions.

Shipments of plutonium residues and scrub alloy that meet requirements for disposal at WIPP would be transported to WIPP in TRUPACT-II containers. This container could also be used to transport materials for offsite processing.





Two Type B Packagings that Could be Used to Ship Plutonium Residues and Scrub Alloy.

2.8.2 THE "SAFE SECURE TRAILER" SYSTEM

The Safe Secure Trailer System would be used to transport plutonium residues and scrub alloy for processing at the Savannah River Site or at Los Alamos National Laboratory. The Safe Secure Trailer System is an integral part of the Transportation Safeguards System operated by DOE. The Transportation Safeguards System is normally used to transport nuclear weapons, nuclear weapon components, and special nuclear materials. Since its establishment in 1975, the Transportation Safeguards Division has accumulated more than 110 million kilometers (70 million miles) of over-the-road experience transporting cargo without a fatality or radioactive release.

The Safe Secure Trailer System uses specially designed 18-wheel tractor trailers, which incorporate deterrents to prevent unauthorized removal of cargo. Key features of the system include:

- superior structural characteristics and a highly reliable cargo tiedown system;
- communications, electronic, and other equipment that further enhance in-transit safety and security;
- specially trained and equipped personnel accompanying the shipment, driving the truck and escort vehicles, and operating the communications and other equipment;
- a comprehensive maintenance program, including compliance with maintenance standards significantly more stringent than those applied to similar commercial transport vehicles; and
- periodic and unannounced audits/surveys during transport operations to ensure compliance with approved procedures.

Safe Secure Trailer System

2.8.3 ROUTE SELECTION PROCESS FOR OFFSITE TRANSPORTATION

Highway routing of nuclear material is governed by Department of Transportation Regulations at 49 CFR Parts 171-179 and 49 CFR Part 397. The regulations require that shipment of a "highway route controlled quantity" of radioactive material be transported over a preferred highway network. The network includes interstate highways, with preference toward interstate system bypasses around cities, and State-designated preferred routes.

A computer code called HIGHWAY was used to select representative routes for conducting the risk assessment in this EIS. The HIGHWAY code is a computerized road atlas that provides selection of routes in compliance with the Department of Transportation preferred highway network.

For security reasons associated with Safe Secure Trailer shipments, details about routes for such shipments would not be publicized before shipment.

2.8.4 EMERGENCY MANAGEMENT CONSIDERATIONS

DOE's Transportation Safeguards Division is responsible for the safety and security of special nuclear material shipments. Most, if not all, plutonium residues and scrub alloy shipments would be treated as special nuclear material shipments and would be accompanied by armed special agents who would be in constant communication with the Transportation Safeguards Division Control Center.

In the event of an incident or accident, the Transportation Safeguards Division convoy commander would notify Security Communications (SECOM), which is a nationwide communications system operated 24 hours per day by the Transportation Safeguards Division. SECOM would then notify the State's emergency point of contact and would interface with emergency responders. The Transportation Safeguards Division would maintain control over the immediate scene of any accident, called a "National Security Area." Beyond that, State or local officials would be in command of the scene. First on-scene responders would receive a briefing from the Transportation Safeguards Division Special Agents. The incident commander would be apprised of the security requirements and of the hazardous nature of the shipment in advance of directing the responders to begin their response.

DOE has eight regional Radiological Assistance Program teams available to respond to incidents involving plutonium residue or scrub alloy shipments.

The DOE Transportation Emergency Preparedness Program provides Federal, Tribal, State, and local responders with access to training and technical assistance necessary to safely, efficiently, and effectively respond to DOE transportation incidents involving radioactive materials.

2.9 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 proliferation 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 while processing the materials to address near-term health and safety issues raised by the Defense Nuclear Facilities Safety Board in its Recommendation 94-1. This processing would also prepare the residues and scrub alloy for disposal or other disposition, thus allowing the elimination of the health and safety risks associated with further storage of these materials. 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 Environmental Impact Statement*. The ultimate disposition of this plutonium would be in a monitored geologic repository either as a glass or 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 would, therefore, be very low under this alternative.

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.