Plan for Alternative Disposition of Defense Plutonium and Defense Plutonium Materials That were Destined for the Cancelled Plutonium Immobilization Plant

Department of Energy

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That were Destined for the Cancelled Plutonium Immobilization Plant

I. Introduction

In accordance with section 3155 of the National Defense Authorization Act for Fiscal Year 2002 (Public Law 107-107) (NDAA), the Department of Energy (DOE) has prepared this plan for the alternative disposition of up to 13 metric tons (MT) of defense plutonium and defense plutonium materials that had been planned for disposition in the cancelled Plutonium Immobilization Plant (PIP).

Section 3155 of the NDAA addresses certain requirements and reporting responsibilities of the DOE with respect to the disposition of surplus defense plutonium and defense plutonium materials either stored at or to be shipped to the Savannah River Site (SRS). Among the requirements of section 3155 is subsection (d), which provides that: "[i]f the Secretary determines not to proceed at the Savannah River Site with construction of the plutonium immobilization plant, or with the mixed oxide fuel fabrication facility, the Secretary shall prepare a plan that identifies a disposition path for all defense plutonium and defense plutonium materials that would otherwise have been disposed of at such plant or such facility, as applicable." Further, section 3155(f) provides that the Secretary shall be prohibited from shipping defense plutonium or defense plutonium materials to the SRS until the date the plan for alternative disposition (if required under subsection (d)), is submitted to Congress. Lastly, section 3155(b) provides that no less than 30 days prior to shipment of defense plutonium or defense plutonium materials to SRS, DOE must submit to the congressional defense committees a report providing notice of such shipments.

When section 3155 of the NDAA was enacted (November 2001), DOE had planned a two-pronged approach to the disposition of its defense plutonium and defense plutonium materials (hereafter "surplus plutonium"): 1) the disposition of up to 17 MT of surplus plutonium through immobilization technologies in the PIP to be located at SRS; and 2) the disposition of 33 MT of surplus plutonium in the Mixed Oxide Fuel Fabrication Facility (MFFF), also to be located at SRS. However, in April 2002, DOE decided to cancel the PIP and proceed with only the construction and operation of the MFFF at SRS. The cancellation of the PIP left up to 17 MT of surplus plutonium without an identified path to disposal. Subsequently, DOE determined four of the 17 MT should be retained for future programmatic use, thereby resulting in the current amount of up to 13 MT without an identified disposition path.

Now, DOE's preferred option is to consolidate the surplus plutonium currently stored at the Hanford site, Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL) to SRS and, along with surplus plutonium already stored at SRS, disposition this surplus plutonium utilizing up to three facilities: a proposed, small-scale Plutonium Vitrification process, if needed; the existing H-Canyon facility; and the planned MFFF. DOE's plan also includes evaluation of an alternative approach that would either further reduce or

eliminate the need for the vitrification process[1] and instead disposition the surplus plutonium through the MFFF and H-Canyon. Under any of these options, DOE has a disposition plan to remove from the State of South Carolina any surplus plutonium transferred to the SRS, or in storage at the SRS, that originally was planned for disposition in the PIP[2]. Consolidation and disposition of surplus plutonium at SRS would provide several important benefits to DOE and the public, including: enhanced security of the materials at a single location; reduced risk that plutonium poses to the public and the environment; and reduced or avoided costs associated with plutonium storage, surveillance and monitoring, and security at multiple sites.

II. Background

A. History of Disposition Strategy for all Surplus Plutonium

The end of the Cold War left a legacy of surplus weapons-usable fissile materials both in the United States and the former Soviet Union, leaving substantial quantities of plutonium no longer needed for defense purposes. The global stockpiles of weapons-usable fissile materials pose a danger to national and international security in the form of potential proliferation of nuclear weapons and the potential for environmental, safety, and health consequences if the materials are not properly safeguarded and managed. In September 1993, in response to these concerns, President Clinton issued a *Nonproliferation and Export Control Policy* which committed the United States to 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.

On March 1, 1995, approximately 200 MT of U.S.-origin weapons-usable fissile materials were declared surplus to U.S. defense needs (38.2 MT of weapon-grade plutonium and 174.3 MT of highly enriched uranium). In addition, DOE announced that it had 14.3 MT of other than weapon-grade plutonium that would be included in the disposition program.

Acting upon this declaration, DOE prepared the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (PEIS) to evaluate various storage and disposition options for its surplus weapons-usable fissile material. In a 1997 Record of Decision (ROD) for the PEIS, DOE decided that it would consolidate the storage of weapons-usable plutonium at upgraded and expanded existing and planned facilities at the Pantex Plant in Texas and the SRS in South Carolina, and continue the storage of weapons-usable highly enriched uranium in upgraded facilities at DOE's Y-12 Plant at the Oak Ridge Reservation in Tennessee. After certain conditions were met, most plutonium stored at the Rocky Flats Environmental Technology Site (RFETS) in Colorado would be moved to Pantex and SRS. Plutonium stored at the Hanford site, the Idaho National Engineering and Environmental Laboratory (INEEL), and LANL would remain at those sites until disposition (or movement to lag storage prior to disposition). In accordance with the ROD, DOE would provide

[1] DOE is also evaluating an alternative option for immobilization that would use a ceramic, rather than glass, form in a process similar to the proposed vitrification process.

[2] DOE activities and facilities described in this alternative disposition plan are subject to completion of appropriate review under the National Environmental Policy Act, the availability of funding, compliance with other applicable laws, and associated decisions.

for disposition of surplus plutonium by pursuing a strategy that allowed: 1) immobilization of surplus plutonium for disposal in a repository pursuant to the Nuclear Waste Policy Act; and 2) fabrication of surplus plutonium into mixed-oxide (MOX) fuel for use in existing domestic commercial light-water reactors.

In November 1999, DOE issued the *Surplus Plutonium Disposition Final Environmental Impact Statement* (EIS). This EIS evaluated the environmental impacts of conducting plutonium disposition activities at the following DOE locations: Hanford, SRS, INEEL and the Pantex Plant. This was followed, in January 2000, by the *Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement* (65 Fed. Reg. 1608, January 11, 2000), in which DOE decided to implement a dual-track approach for disposition of surplus plutonium. DOE decided to construct and operate three facilities at the SRS, located near Aiken, South Carolina: the Pit Disassembly and Conversion Facility (PDCF) would prepare plutonium materials for disposition in the MFFF; the MFFF would manufacture MOX (using plutonium oxide and uranium oxide) fuel for use in commercial nuclear power reactors; and the PIP would prepare up to 17 MT of plutonium materials for disposal in the national geologic repository using a ceramification process. DOE reasoned that pursuing this approach provided the best opportunity for U.S. leadership in working with Russia to implement similar options for reducing Russia's excess plutonium. Further, it would send the strongest possible signal to the world of U.S. determination to reduce stockpiles of surplus weapons-usable plutonium as quickly as possible and in an irreversible manner.

Making good on a pledge made at a 1998 Summit, the United States and Russia entered into a Plutonium Management and Disposition Agreement in September 2000 that committed each country to dispose of 34 MT of surplus weapon-grade plutonium.

In 2001, DOE undertook a review of U.S. plutonium disposition cooperation with Russia so as to identify a more cost-effective approach. This review resulted in a refined approach under which the U.S. would rely on the irradiation of mix oxide fuel to dispose of surplus plutonium. After preparation of a Supplemental Analysis pursuant to the National Environmental Policy Act (NEPA), DOE issued an *Amended Record of Decision, Surplus Plutonium Disposition Program* (67 Fed. Reg. 19432, April 19, 2002) which, among other things, cancelled the PIP. Under the new approach, 34 MT of surplus plutonium would be fabricated into mix oxide fuel. The decision to cancel the immobilization program was based on two factors. First, Russia refused to dispose of its surplus plutonium if the United States pursued an immobilization-only strategy. Second, budget considerations dictated that only one program could go forward.

In the following year, DOE issued an *Amended Record of Decision, Surplus Plutonium Disposition Program* (68 Fed. Reg. 20134, April 24, 2003), in which DOE decided to pursue a program of fabricating into mix oxide fuel approximately 6.5 MT of surplus plutonium originally intended for immobilization, including the material transferred from RFETS to SRS for storage, that after appropriate sampling for actual material characteristics, may be determined to meet the MFFF's specifications. DOE also decided that approximately 4 MT of the up to 17 MT of surplus plutonium previously intended for immobilization would be retained for potential future

programmatic use. Therefore, cancellation of the immobilization strategy left at least 7 MT and up to 13 MT of surplus plutonium without a defined disposition path.

In keeping with its commitments under the 2000 U.S.-Russia Plutonium Management and Disposition Agreement and the *Amended Record of Decision, Surplus Plutonium Disposition Program*, 2002, DOE proceeded with its plans for the construction and operation of the MFFF. In March 2005, the Nuclear Regulatory Commission issued a construction authorization for the MFFF, and in September 2006 DOE's contractor submitted a license application to receive and possess (operate) the MFFF. Much of the detailed design of the MFFF has been completed and site preparation activities concluded. On August 1, 2007, DOE will begin construction of the MFFF.

B. Current Status of Disposition Strategy for All Surplus Plutonium

DOE's baseline approach for disposing of the approximately 43 MT of weapons-usable (both weapon and non-weapon grade) plutonium surplus (or to be declared surplus) to U.S. defense needs was described in a recent report entitled, "Business Case, DOE's Proposed Baseline Approach for Disposing of Surplus Plutonium," (Business Case) submitted to Congress in April, 2007. (Attachment 1) Under the baseline approach the Department plans to:

- Construct and operate a MFFF, a PDCF, and a Waste Solidification Building (WSB) to dispose of at least 34 MT of weapon-grade plutonium consistent with the September 2000 U.S.-Russia Plutonium Management and Disposition Agreement;

- Design, construct and operate a new, small-scale Plutonium Vitrification process in the basement level of the K-Reactor Building to vitrify up to 13 MT of surplus plutonium (the material that is the subject of this plan); and

- Operate the existing H-Canyon facilities to process approximately 2 MT of plutonium-bearing materials (which includes some plutonium that is currently unsuitable for fabrication into mix oxide fuel and that is also not suitable for disposition using the vitrification capability) for disposal through the SRS radioactive waste system (for vitrification with high level waste in the Defense Waste Processing Facility (DWPF)) concurrent with operation of H-Canyon for the recovery of enriched uranium for subsequent down-blending to low enriched uranium and sale.

As explained below, currently available information indicates that, of the up to 13 MT available for possible vitrification, approximately 4 MT is suitable and planned for disposition utilizing the MFFF. In addition, DOE is evaluating the cost and feasibility of further reducing or eliminating the mission of the Plutonium Vitrification process (e.g., use only the MFFF and H-Canyon to dispose of the 13 MT of surplus plutonium). Based on further analysis, DOE will determine the need for the Plutonium Vitrification process as part of Critical Decision-1, planned for late 2007.

C. Characteristics of the Surplus Plutonium Destined for the Cancelled PIP

The 17 MT of surplus plutonium originally intended for disposal using the cancelled PIP consists of 4 MT at Hanford (3.3 MT packaged in DOE-STD-3013 plutonium long-term storage containers and 0.7 MT in unirradiated fuel assemblies and pieces of fuel assemblies), approximately 0.5 MT at the Los Alamos National Laboratory, approximately 0.2 MT at the LLNL, approximately 4 MT at the Idaho National Laboratory (INL), and the remainder at SRS. The 4 MT at INL is in unirradiated Zero Power Physics Reactor fuel and is the material being retained for potential future programmatic use. Accordingly, there currently is up to 13 MT of surplus plutonium requiring a new disposition path. Currently available information indicates that this surplus plutonium could be distributed among the three disposition facilities (mix oxide, the proposed small-scale plutonium vitrification process, and H-Canyon) based on the following material characteristics:

Disposition Approach	**Quantity**	**Characteristics**
MOX	**~4 MT**	- **Other Metal & Oxide:** Clean WG (Weapon-Grade) (less than 10% Pu-240) Oxide and Slightly Impure WG Oxide
Plutonium Vitrification Capability	**~5 MT**	- **Impure Metal & Oxide:** Clean FG (Fuel-Grade) (greater than 10% but less than 19% Pu-240) Metal; Clean FG Oxide; Impure Plutonium Oxide with Chloride; Impure Plutonium Metal with Chloride
	~2 MT	- **Impure Metal & Oxide:** Power-Grade Oxide (19+% Pu-240); Fast Flux Test Facility Green Fuel (70% Uranium); Plutonium Oxide with Fluoride; Plutonium Oxide with Beryllium (Be); Plutonium Oxides and Metal with Thorium
H-Canyon	**~2 MT**	- **Very Impure Materials:** Material from 3013 Container Surveillances; Plutonium-Beryllium Metal; Plutonium-Vanadium Metal; Pu-Depleted Uranium Metal; Plutonium-Tantalum Metal; and Oxide with High Uranium Content

III. Disposition Plan for Surplus Plutonium Destined for the Cancelled PIP

A. Preferred Disposition Option

DOE's preferred option for the disposition of the up to13 MT of surplus plutonium originally destined for the PIP involves the use of a proposed new, small-scale Plutonium Vitrification process (if needed), the existing H-Canyon facility, and the MFFF. This option would establish the capability in the K-Reactor building to prepare for disposition the surplus plutonium by vitrifying it in lanthanide borosilicate (LaBS) glass. The small containers of LaBS glass would then be placed into DWPF canisters and filled with high-level waste glass; the DWPF containers would ultimately be shipped to the geologic repository for disposition. A more detailed description of the Plutonium Vitrification process is provided in Appendix A. In addition, H-Canyon would be used to process approximately 2 MT of the plutonium, with the resulting high-level waste sent to SRS tanks and the DWPF. The MFFF would be used to fabricate approximately 4 MT of the surplus plutonium into MOX fuel.

Preliminary planning for disposition of the surplus plutonium led to a decision in 2005 by Deputy Secretary Sell to approve the Mission Need, or Critical Decision-0 (CD-0), for the new Plutonium Disposition Project (also referred to as the Plutonium Vitrification process) at SRS for the up to 13 MT of surplus plutonium formerly planned for disposition in the PIP. The CD-0 package was prepared pursuant to DOE Order 413.3A, "Program and Project Management for the Acquisition of Capital Assets." This Order describes the process that DOE uses for managing capital projects. In accordance with DOE Order 413.3A requirements, DOE conducted a technical analysis of various conceptual design alternatives that had the potential to fulfill the mission need to disposition the surplus plutonium. On August 17, 2006, the Deputy Secretary approved the selection of vitrification as the Preferred Technology Alternative (CD-1A).

Since approval of CD-1A, DOE has been engaged in conceptual design work on the Plutonium Vitrification process and additional work on an evaluation of the cost and feasibility of reducing or eliminating the Plutonium Vitrification process and instead dispositioning the plutonium using only the H-Canyon and MFFF. This continuing evaluation will address technical and cost uncertainties to inform the next critical decision, CD-1, planned for late 2007, on the need for the Plutonium Vitrification process. The Plutonium Vitrification process may not be needed if it is determined that it is feasible and cost-effective to disposition all the approximately 13 MT using only the MFFF and H-Canyon.

B. Alternatives to the Preferred Disposition Option

As described above, DOE obtained approval of the Mission Need, or CD-0, for the Plutonium Disposition Project in 2005. As part of the critical decision process, DOE conducted conceptual design activities for the new vitrification project, including an analysis of disposition alternatives documented in a report entitled, "Plutonium Disposition Alternatives Analysis," Document No. Y-AES-G-00001, Revision 0, dated May 2006. During the initial screening some alternatives were eliminated from further detailed analysis for various reasons, including criticality issues, legal restrictions, unrealistic disposition schedule, or being bounded by another

alternative. The remaining alternatives were then evaluated in more detail and subsequently ranked using appropriately weighted decision criteria. Those criteria were: requirements (e.g., ability to meet regulatory or program or repository requirements); technical/scope (e.g., process maturity, maintainability, design complexity); environment, safety and health (e.g., nuclear safety, fire protection); safeguards and security (e.g., resistance to theft or diversion); impact to other programs/missions; schedule; and lifecycle cost. The alternatives that were considered included various technologies and combinations of technologies such as vitrification, ceramification, MFFF processing, H-Canyon processing, and disposal in either a high-level waste repository or the Waste Isolation Pilot Plant. Appendix B provides a table with a complete listing of the alternatives considered, including whether the alternative was analyzed in detail or screened out earlier in the process. Base on the results of the detailed analysis of alternatives, the preferred alternative was determined to be vitrification in K-Area.

More recently, DOE began evaluating approaches that would utilize only the MFFF and H-Canyon. Based on a recent review by outside experts, and an assessment by Shaw-AREVA MOX Services (the contractor for the MFFF) of what plutonium materials can likely be fabricated into MOX fuel, engineers are currently evaluating the cost and technical feasibility of maximizing the use of the MFFF and further reducing or eliminating the mission that is currently proposed for the Plutonium Vitrification process. As described in the Business Case, this approach could entail disposing of up to 9 MT of surplus plutonium using the MFFF and up to 4 MT using H-Canyon. Eliminating the mission for the Plutonium Vitrification process would result in the MFFF and H-Canyon processing additional plutonium, therefore requiring some modifications to both facilities. DOE will continue to evaluate this option to determine whether it presents a more cost effective, technically feasible method of disposal that provides a path out of the State of South Carolina and meets U.S. nonproliferation and national security goals.

As part of its NEPA review of alternative disposition technologies (discussed further below), DOE is also analyzing an immobilization alternative that would result in a ceramic, rather than glass, waste form that, similar to the vitrification alternative, would be placed inside cans to go into canisters in DWPF. *Notice of Intent to Prepare a Supplemental Environmental Impact Statement for Surplus Plutonium Disposition at Savannah River Site*, issued in March 2007 (72 Fed. Reg. 14543, March 28, 2007).

C. Schedule and Estimated Costs

In the Business Case, DOE presented a financial analysis of DOE's proposed baseline for all surplus plutonium disposition. The analysis included the estimated costs and operating schedules for the facilities to disposition the up to 13 MT of surplus plutonium that is the subject of this plan. Based on data available at issuance of the Business Case, DOE provided estimates of the net present value cost (excluding sunk costs), discounted in 2006 dollars, of the proposed Plutonium Vitrification process (to process approximately 7 MT), the MFFF (to process 34 MT, including 4 MT that is part of the up to 13 MT addressed in this plan) and H-Canyon (to process approximately 2 MT and operate in conjunction with other DOE missions). The time period covered was 2007 through 2034, thereby including current year expenditures. In summary, those estimated costs are: $797 million for the Plutonium Vitrification process; $3,402 million for the MFFF; and $340 million for H-Canyon. A more detailed presentation of the assumptions, cost

calculations, and period of operation for the disposition facilities is contained in the Business Case (Attachment 1, pages 11 to 13).

E. NEPA Review

The disposition activities and facilities presented in this plan have undergone, or are undergoing, appropriate NEPA review prior to a final decision by DOE. In March 2007, DOE issued a Notice of Intent (NOI) to prepare a Supplemental Environmental Impact Statement (SEIS) (72 Fed. Reg. 14543) tiered off the *Surplus Plutonium Disposition Final Environmental Impact Statement* (DOE/EIS-0283, November 1999) that would analyze the potential environmental impacts of alternative disposition technologies for the disposition of up to 13 MT of surplus plutonium that does not have a defined path to disposition as a result of the cancellation of the PIP. In the NOI, DOE stated the preferred alternative at that time to construct and operate a vitrification facility within the basement of the K-Area Reactor that would immobilize plutonium within lanthanide borosilicate glass inside stainless steel cans; the cans then would be placed within larger canisters to be filled with vitrified high-level waste in the DWPF; and the canisters subsequently disposed in a geologic repository. In addition, H-Canyon would be used to process some of the surplus plutonium and then sent to the high-level waste tanks and DWPF. DOE also indicated in the NOI that alternative disposition technologies would be analyzed in the SEIS.

Specifically, the SEIS would include analysis of the alternative of utilizing the MFFF to disposition some of the 13 MT of surplus plutonium, including the possibility of utilizing the MFFF to disposition up to 9 MT of surplus plutonium should that alternative be reasonable. The SEIS also would analyze an immobilization alternative that would result in a ceramic, rather than glass, waste form that, similar to the vitrification alternative, would be placed inside cans to go into canisters in DWPF. All alternatives (except the no action alternative) would include processing some of the surplus plutonium, up to 4 MT, through the H-Canyon. DOE is evaluating the continued use of H-Canyon for uranium processing in a separate NEPA document, a supplement analysis scheduled for completion in 2007.

A Draft SEIS is tentatively scheduled to be completed January 2008, followed by public hearings, with a Final SEIS issued in July 2008. The issuance of the Final EIS and an associated ROD would provide the necessary and appropriate NEPA review for DOE's plan for the alternative disposition of the surplus plutonium that was planned for disposition using the cancelled PIP.

F. Disposition Path and Removal from South Carolina

Based on the above, DOE has a plan for disposing of all surplus plutonium that would otherwise have been disposed of using the cancelled PIP. This surplus plutonium would be disposed of utilizing up to three facilities: a proposed, small-scale Plutonium Vitrification process, if needed; the existing H-Canyon facility; and the planned MFFF. DOE's plan also includes evaluation of an alternative approach that would either further reduce or eliminate the need for the vitrification process and instead disposition the surplus plutonium through the MFFF and H-Canyon. DOE is evaluating an immobilization alternative that would use a

ceramic, rather than glass, form in a process similar to the proposed vitrification process. Under any of these options, DOE has a disposition plan to ensure that any surplus plutonium transferred to the SRS, or in storage at the SRS, that originally was planned for disposition in the PIP has an identified disposition path out of South Carolina.

Appendix A

The proposed plutonium vitrification process includes the activities described below.

Oxidation: Oxidation receives DOE-STD-3013 containers with plutonium metal from storage. (The unirradiated fuel assemblies will be disassembled prior to transfer to oxidation.) The plutonium metal is converted to an oxide in Direct Metal Oxidation Furnaces and the resultant oxide is packaged in convenience cans. The output from Oxidation is transport cans of oxide that are sent to Feed Preparation.

Feed Preparation: Feed Preparation receives 3013 containers of oxide from storage and transport cans of oxide from Oxidization. The output from Feed Preparation is batching cans with 2 kg of crushed/screened oxide, with a particle diameter less than 1 mm, that are sent to Milling/Mixing.

Milling/Mixing: The Milling/Mixing process step combines the plutonium feed with LaBS glass frit. Milling/Mixing is accomplished using an attritor mill to produce the necessary particle size to ensure dissolution and incorporation of the plutonium into the glass and a homogenous mixture. The resulting mix is loaded into melter batch cans and sent to Vitrification. Plutonium oxide feed is received into the Milling/Mix glovebox from the Feed Preparation glovebox.

Vitrification: In Vitrification the Plutonium feed/LaBS frit mixture is vitrified into glass cans using a Cylindrical Induction Melter (CIM). The CIM is a compact, high temperature (1600° C capability) melter. A Platinum/Rhodium (Pt/Rh) vessel is used to contain the melt and a Pt/Rh drain tube is used to discharge the molten glass. The resultant glass cans are transported to Bagless Transfer.

Waste Handling/Loading: Waste Handling/Loading handles waste generated from this process. This activity removes waste from the generation point, performs the appropriate measurements, packages waste, and prepares waste for shipment to the disposal location.

Bagless Transfer: Bagless Transfer allows the can of glass to be removed from the glovebox in a non-contaminated state by emplacing the glass can in a bagless transfer can. The bagless transfer system previously utilized in FB-line is expected to be the basis for the bagless transfer system for the plutonium vitrification effort. The bagless transfer cans are transported to Magazine Loading/Storage.

Magazine Loading/Storage: Magazine Loading/Storage receives bagless transfer cans, assembles the cans into magazines, and stores the magazines.

Canister Loading/Shipping: Canister Load/Ship assembles can-in-canister assemblies that are suitable for filling with HLW glass and ships the canisters to DWPF.

DWPF Modifications: Specific modifications to DWPF will be required to allow for receipt and handling of can-in-canister assemblies. The can-in-canister assemblies differ from typical DWPF canisters in that they contain significant quantities of special nuclear material, emit substantially more radiation, and are heavier. Safeguards measures, including the potential use of a protective force, will be necessary for receipt and movement of the can-in-canister assemblies. Specific shielding and/or remote operation measures will be required to handle the canisters. Due to the weight of the can-in-canister assembly, modifications to existing canister handling equipment (loading dock, forklift, crane, etc.) will likely be required.

Appendix B

No.	Alternative Title	Alternative Description	Evaluation Status
1	"Can-in-Canister" (Vitrified) to High Level Waste (HLW) Repository	Plutonium is vitrified into small cans in K-Area and loaded into DWPF canisters for shipment to DWPF where the canisters are filled with vitrified HLW, stored in a Glass Waste Storage Building (GWSB), and ultimately shipped to a HLW repository.	Analyzed in detail
1A	"Can-in-Canister" (Ceramic) to HLW Repository	Plutonium is processed into a ceramic form (puck) in small cans in K-Area and loaded into DWPF canisters for shipment to DWPF where the canisters are filled with vitrified HLW, stored in a GWSB, and ultimately shipped to a HLW repository.	Analyzed in detail
2	New Vitrification in K-Area Direct to Waste Isolation Pilot Plant (WIPP)	Plutonium is vitrified into small cans in K-Area and loaded into shipping containers for shipment to WIPP.	Screened out (Combined with 7)
2A	New Ceramic Capability in K-Area Direct to WIPP	Plutonium is processed into a ceramic form (puck) in small cans in K-Area and loaded into shipping containers for shipment to WIPP.	Screened out (Combined with 7)
3	"Can-in Canister" (3013) to HLW Repository	Plutonium in DOE-STD-3013 containers is loaded into DWPF canisters for shipment to DWPF where the canisters are filled with vitrified HLW, stored in a GWSB, and ultimately shipped to a HLW repository.	Screened out (Waste form qualification; DWPF processing; plutonium loading; safeguards and security)
4A	MFFF + H-Canyon Head-end Processing to MOX Fuel	Plutonium meeting the MOX fuel specification is processed in MFFF during its non-proliferation mission. The remainder is purified/oxidized in H-Area and then transferred to MFFF.	Screened out (4B more desirable)
4B	MFFF/H-Canyon Hybrid (half to MOX and half to HLW)	Plutonium meeting the MOX fuel specification is processed in MFFF during its non-proliferation mission. The remainder is dissolved in H-Area, transferred to HLW and vitrified in DWPF, stored in a GWSB, and ultimately shipped to a HLW repository.	Analyzed in detail

4C	Upgraded MFFF	Plutonium meeting the MOX fuel specification is processed in MFFF during its non-proliferation mission. MFFF is then modified to enable processing of the remaining plutonium into MOX fuel.	Analyzed in detail
4D	MOX Feed – Upgraded MFFF to Waste Solidification Building (WSB) to WIPP	Plutonium meeting the MOX fuel specification is processed in MFFF during its non-proliferation mission. MFFF and WSB are then modified to enable processing of the remaining plutonium to produce a waste form acceptable for WIPP. The waste is packaged and shipped to WIPP.	Screened out (WSB modifications too extensive, and much more extensive than 4C and 7)
4E	MOX Feed – Upgraded MFFF to MOX Fuel (prior to MOX mission start)	Similar to 4C, but MFFF is modified immediately to enable processing of all 13 MT of surplus non-pit plutonium.	Screened out (Modifications to MFFF would result in significant delays to its non-proliferation mission)
5A	Dissolution in H-Canyon to DWPF to HLW Repository (process and safeguards and security Category I upgrades)	Plutonium in 3013 containers is shipped to H-Area, processed to solution, and transferred to the Liquid Waste System for blending with HLW. The unirradiated fuel is charged directly to the H-Canyon dissolvers. The resultant solution is fed to DWPF for vitrification and placement in HLW canisters, stored in a GWSB, and ultimately shipped to a HLW repository. Upgrades are made to increase throughput and to enable the H-Canyon facilities to process Category I quantities of material.	Analyzed in detail
5B	Dissolution in H-Canyon to DWPF to HLW Repository (process upgrades, but remains Category II)	Plutonium in 3013 containers is shipped H-Area, processed to solution, and transferred to the Liquid Waste System for blending with HLW. The unirradiated fuel is charged directly to the H-Canyon dissolvers. The resultant solution is fed to DWPF for vitrification and placement in HLW canisters, stored in a GWSB, and ultimately shipped to a HLW repository. Upgrades are made to increase throughput, but the H-Canyon facilities are maintained as Category II	Analyzed in detail

		facilities.	
5C	Dissolution in H-Canyon to DWPF to HLW Repository (without upgrades)	Plutonium in 3013 containers is shipped H-Area, processed to solution, and transferred to the Liquid Waste System for blending with HLW. The unirradiated fuel is charged directly to the H-Canyon dissolvers. The resultant solution is fed to DWPF for vitrification and placement in HLW canisters, stored in a GWSB, and ultimately shipped to a HLW repository. No upgrades are made to increase throughput or for security.	Screened out (Processing would not be completed until 2043; 5A and 5B are much more desirable)
6	Modified WSB to WIPP	Upon completion of the MOX program the WSB is modified to process plutonium to a WIPP acceptable waste matrix, which is then packaged and shipped to WIPP.	Screened out (WSB modifications too extensive, and much more extensive than 7)
7	Stabilized Matrix Direct to WIPP	Plutonium is processed into a stabilized waste matrix form and packaged into WIPP acceptable containers in K-Area, then loaded into WIPP approved shipping containers and stored in the Waste Disposal Facility until shipment to WIPP.	After an initial evaluation, this alternative was subsequently screened out (Does not comply with section 309 of Public Law 109-103)
8	Continued Storage	Plutonium is maintained in K-Area storage until a disposition path becomes available. Maintenance and surveillance activities are conducted as long as the material remains in storage.	Screened out (Does not result in disposition of the plutonium)
9	New Facility	A new facility is constructed to process plutonium for disposition.	Screened out (Significantly less cost effective and timely than using an existing facility in K-Area)
10A	New Vitrification in K-Area and Dispose to HLW Repository With Spent Nuclear Fuel (SNF)	Plutonium is vitrified into small cans in K-Area and loaded into fuel tubes, stored in L-Area, and ultimately loaded with SNF into DWPF canisters and shipped to a HLW repository.	Screened out (Space limitations in L-Area; SNF not self protecting for HLW repository; SNF form for repository not yet defined)
10B	New Ceramic in K-Area	Plutonium is processed into a ceramic	Screened out (Same

	and Dispose to HLW Repository With SNF	form (puck) in small cans in K-Area and loaded into fuel tubes, stored in L-Area, and ultimately loaded with SNF into DWPF canisters and shipped to a HLW repository.	reasons as 10A)
11A	Melt/Dilute to HLW Repository	Depleted uranium, aluminum, and other metals are melted in a furnace. Plutonium and, if necessary, neutron absorber materials are then added and the resultant product is solidified, placed in a canister, and stored in concrete storage modules until eventual shipment to a HLW repository.	Screened out (Waste form not self protecting; criticality issues; qualification of waste form for the HLW repository; melt/dilute development was stopped several years ago due to lack of funding)
11B	Melt/Dilute (LEF) to WIPP	Depleted uranium, aluminum, and other metals are melted in a furnace. Plutonium and, if necessary, neutron absorber materials are then added and the resultant product is solidified, placed in a WIPP approved container, then packaged and shipped to WIPP.	Screened out (Same reasons as 11A)