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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of Defense Plutonium and Defense Plutonium Materials
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; 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 proposed 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: 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 certain 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 the 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 mixed 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 mixed 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 another *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 mixed 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 began 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 proposed 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 mixed oxide fuel and that is also not suitable for disposition using the proposed 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.

The Business Case 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 (MFFF, 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 to 13 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. The preferred option is presented in the Business Case, including a financial analysis and schedule. This option would establish the capability in the K-Reactor building to prepare for disposition of 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 Attachment 2. 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 the Deputy Secretary to approve the Mission Need, or Critical Decision-0 (CD-0), for the proposed 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. DOE's continuing evaluation will address technical and cost parameters and uncertainties to inform the next critical decision, CD-1, planned for late 2007, on the need for the Plutonium Vitrification process.

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. Attachment 3 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. Based 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. 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. A July 2007 report entitled, "Assessment of the Technical Capabilities of the MOX Fuel Fabrication Facility for Expanded Missions," includes a feasibility analysis and updated cost and schedule information for MFFF to disposition up to 9.7 MT of surplus plutonium. (Attachment 4) 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. This alternative is described in DOE's *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. 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 approximately 9 MT 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.

D. 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, the existing H-Canyon facility; and the MFFF (under construction). 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.

Business Case

DOE's Proposed Baseline Approach for Disposing of Surplus Plutonium

April 2007

BUSINESS CASE

DEPARTMENT OF ENERGY'S PROPOSED BASELINE APPROACH FOR DISPOSING OF SURPLUS PLUTONIUM

EXECUTIVE SUMMARY

This report presents DOE's plan to dispose of inventories of surplus weapons-usable plutonium[1] and includes a discounted cash flow analysis which takes into account the time value of money[2]. Data contained in the analysis are based on information provided by the National Nuclear Security Administration and the offices of Environmental Management and Nuclear Energy with input provided by Dr. David Kosson, Chair of Civil and Environmental Engineering, Vanderbilt University; Dr. Ian Pegg, Professor of Physics and Associate Director of the Vitreous State Laboratory, Catholic University; and Dr. David Gallay, Program Director, LMI Government Consulting.

DOE's proposed baseline approach is designed to accomplish the following three objectives:

1. Dispose of[3] approximately 43 metric tons of surplus weapons-usable plutonium (both weapon and non-weapon grade) so that this material is rendered inaccessible and unattractive for weapons use while protecting human health and the environment. This goal is consistent with long-standing United States national security and nonproliferation policy with respect to eliminating, where

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[1] This report addresses surplus weapons-usable plutonium covered by Public Law 107-107 and Section 4306 of the Atomic Energy Defense Act, as amended. Surplus weapon-grade plutonium, as defined in the U.S.-Russia Plutonium Management and Disposition Agreement (less than 10% Pu-240 and withdrawn from nuclear-weapons programs) is a subset of surplus weapon-usable fissile materials.

U.S. national security and nonproliferation objectives include the disposition of 43 MT of surplus plutonium by rendering it unusable for nuclear weapons use and encouraging Russia to dispose of its surplus weapons plutonium. The 43 MT includes plutonium which has been declared surplus and some plutonium which may be declared surplus to national security defense needs in the future. This does not include surplus plutonium that already has a disposition pathway such as spent fuel, scraps, and residues. The analyses pursuant to the National Environmental Policy Act addressed the environmental impacts of disposition of up to 50 MT of such surplus weapons-usable plutonium, including plutonium that may be declared surplus in the future.

[2] This is consistent with the information used previously in DOE's 2006 report entitled, *Disposition of Surplus U.S. Materials, Comparative Analysis of Alternative Approaches,* and with DOE's 2007 *Business Case Analysis of the Current U.S. Mixed Oxide (MOX) Fuel Strategy for Dispositioning 34 Metric Tons of Surplus Weapon-Grade Plutonium,* although those reports: (1) do not discount future cash flows, and (2) the earlier studies analyzed the combined plutonium and uranium storage costs in lieu of the plutonium storage cost as described in this study.

[3] The phrase "dispose of" is used in this paper, consistent with the phraseology appearing in the 2000 U.S.-Russia Plutonium Management and Disposition Agreement. This paper addresses the costs of disposition prior to ultimate disposal (of mixed oxide spent fuel and vitrified plutonium with high-level waste) in the planned geologic repository for spent fuel and high-level waste at Yucca Mountain, Nevada.

possible, the accumulation of stockpiles of highly enriched uranium and plutonium;

2. Encourage Russia to dispose of 34 MT of its surplus weapons plutonium consistent with the September 2000 U.S.-Russia Plutonium Management and Disposition Agreement; and

3. Consolidate surplus non-pit plutonium currently stored throughout the DOE Complex in order to reduce the risks associated with storage of such materials at multiple sites and to help reduce storage and safeguards and security costs for nuclear materials.

DOE's current proposed baseline approach[4] for disposing of approximately 43 metric tons of surplus plutonium involves the following:

- Construct and operate a Mixed Oxide (MOX) Fuel Fabrication Facility, a Pit Disassembly and Conversion Facility (PDCF), and a Waste Solidification Building (WSB) to dispose of at least 34 MT of weapon-grade plutonium;

- Design, construct and operate a small-scale plutonium vitrification process in the basement level of the K-Reactor Building to vitrify up to 13 MT of non-pit plutonium[5] with high level waste; and

- Operate the existing H-Canyon/HB-Line facilities to process approximately 2 MT of plutonium-bearing materials for disposal through the Savannah River Site radioactive waste system (for vitrification with high level waste in the Defense Waste Processing Facility) concurrent with the recovery of enriched uranium for subsequent down-blending to low enriched uranium and sale.

Based on a recent review by outside experts (cited above), and an assessment by Shaw-AREVA MOX Services (MOX contractor) of what plutonium materials can likely be fabricated into MOX fuel, DOE is currently evaluating the cost and feasibility of reducing or eliminating the mission that is currently being considered for the proposed small-scale Plutonium Vitrification process. Preliminary indications are that this approach could result in cost savings of approximately $500 million (estimated total project cost in constant 2006 dollars, excluding operating costs), although actual savings may change as the design of the small-scale Plutonium Vitrification process progresses. The Department is evaluating the feasibility of the following approach:

[4] The proposed actions described in the following bullets are subject to appropriate review under the National Environmental Policy Act (NEPA), subsequent decisions, and compliance with other applicable law.

[5] This 13 MT includes approximately 2 MT of material currently proposed to be processed in the HB-Line, and vitrified in the Defense Waste Processing Facility and approximately 4 MT of material currently proposed to be fabricated into MOX fuel.

- Construct and operate a Mixed Oxide (MOX) Fuel Fabrication Facility, a Pit Disassembly and Conversion Facility (PDCF), and a Waste Solidification Building (WSB) to dispose of at least 39 MT of weapon-grade plutonium;

- Operate the existing H-Canyon/HB-Line facilities to process approximately 4 MT of plutonium-bearing materials for disposal through the Savannah River Site radioactive waste system (for vitrification with high level waste in the Defense Waste Processing Facility) concurrent with the recovery of enriched uranium for subsequent down-blending to low enriched uranium and sale.

Constructing and operating a Mixed Oxide (MOX) Fuel Fabrication Facility at the Savannah River Site for disposing of surplus plutonium is in the U.S. national interest and consistent with national security and nonproliferation objectives. Doing so will convert plutonium into forms not readily usable for weapons, and will encourage Russia to dispose of 34 metric tons of its excess weapons plutonium in accordance with the 2000 U.S.-Russia Plutonium Management and Disposition Agreement. Proceeding with the U.S. MOX program will also help reduce storage costs for nuclear materials, reduce safeguards and security costs, and support the Department's efforts to consolidate nuclear materials throughout the DOE Complex. The Department of Energy believes that irradiating plutonium as MOX fuel in existing commercial reactors is a prudent and effective means for disposing of surplus plutonium compared to other less mature disposition technologies.

MOX is a proven technology that has been in widespread use in Europe for over three decades. Moreover, the design of the U.S. MOX facility is 90% complete, the Nuclear Regulatory Commission (NRC) has issued a construction authorization, and DOE's contractor has submitted a license application to the NRC for operation of the MOX facility. In addition, MOX fuel lead assemblies, made from surplus weapons plutonium, are currently being successfully tested in a commercial reactor in South Carolina. Thus far, DOE has spent approximately $735 million on the MOX program for design, licensing, and site preparation activities as well as for the fabrication and irradiation of MOX fuel lead assemblies.[6]

DOE's proposed baseline approach provides a disposition path for the currently identified surplus plutonium that is or will be declared surplus in the future. It enables the Department to consolidate special nuclear material (SNM), including the removal of all surplus plutonium from Hanford as well as reducing the inventory of surplus plutonium at the Lawrence Livermore National Laboratory (LLNL) and the Los Alamos National Laboratory (LANL) by 2009. This would result in a reduction of existing Category I special nuclear materials storage (CAT I) facilities, and ultimately would result in the fewest number of DOE CAT I storage facilities, at the earliest date in time. The proposed consolidation would also facilitate the Department's plan to achieve its "Complex 2030" objectives, a more modern, smaller and efficient weapons complex.

[6] The approximately $735 million in sunk costs are not included in this baseline financial analysis. Sunk costs were included in the calculation of life cycle costs provided to the House Committee on Appropriations in March 2007, in accordance with specific direction from that Committee.

As evidenced in the financial analysis, this proposed baseline approach would recover uranium and plutonium from the disposition of surplus fissile materials for energy production providing over two billion dollars in revenues[7] (in constant 2006 dollars) to the U.S. Treasury. Included in this proposed baseline approach is approximately 2 MT of plutonium-bearing materials to be processed through H-Canyon/HB-Line at Savannah River. The net present value cost of this proposed approach (i.e. MOX, the proposed small-scale Vitrification, and H-Canyon) over a 28-year period is approximately $11.1 billion.

In addition to encouraging Russia to dispose of 34 metric tons of weapons plutonium, the capability to disassemble large numbers of nuclear weapons pits in the U.S. and fabricate the resulting plutonium into MOX fuel utilizes a mature technology and could potentially provide the following capabilities:

- Disposition of additional weapons plutonium (beyond the 34 MT) that is expected to be declared surplus as plutonium requirements are reevaluated, in connection with transformation of the nuclear weapons stockpile. While additional declarations would have to be approved by the President based on advice from the Secretaries of Defense and Energy, the MOX and PDCF facilities, once constructed and operating, could readily be used for this purpose. The Deputy Administrator for Defense Programs will specifically raise this request with the Nuclear Weapons Council.

- Currently, DOE is evaluating both metal and oxide fuel forms for use as the start-up fuel for fast reactors in support of the Global Nuclear Energy Partnership (GNEP). A decision on the fuel form for the fast reactors will be made at a future time. Given that the necessary GNEP fuel-related decisions are in the future, it is not reasonable to delay construction of the MOX facility to incorporate the potential GNEP required design and construction changes. Continued delays in MOX construction will result in increased costs and postpone the start of facility operations. DOE will continue to evaluate the option to use the MOX facility in support of fast reactor start-up fuel as the requirements for GNEP are developed. In 2008, the Secretary of Energy plans to determine a path forward for GNEP.

- Disposition of additional impure plutonium, e.g. plutonium containing levels of chlorides, fluorides and Pu-240, currently proposed to be dispositioned in DOE's proposed small-scale Plutonium Vitrification process. The Department is evaluating the cost and technical feasibility of maximizing the use of the MOX facility and reducing the mission that is currently being considered for the

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[7] Revenue is comprised of approximately $1.5 billion from the sale of MOX fuel and $700 million from the sale of uranium from dismantled nuclear weapons pits. Both are based on the prevailing price of uranium, which has been extremely volatile in recent years The discounted cash flow analysis used in this Business Case conservatively assumes that uranium and enrichment market prices that prevailed in November 2006 will prevail throughout the period of interest when the fuel materials will enter the market.

proposed small-scale Plutonium Vitrification process.

In conclusion, DOE's proposed baseline approach for disposing of surplus plutonium (MOX, the proposed small-scale Plutonium Vitrification process, and H-Canyon) would meet U.S. national security and nonproliferation objectives for disposing of 43 MT of surplus plutonium by rendering it unusable for nuclear weapons use, and encouraging Russia to dispose of its surplus weapons plutonium. In addition, the proposed baseline approach will help reduce storage costs for nuclear materials, reduce safeguards and security costs, and support the Department's efforts to consolidate nuclear materials within the DOE Complex.

BACKGROUND
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.

In early 1994, the U.S. National Academy of Sciences issued a report evaluating a number of plutonium disposition alternatives ranging from sending it into space to burying it under the ocean floor, before recommending two promising alternatives for further study: (1) fabrication and use as fuel, without reprocessing, in existing or modified nuclear reactors, or (2) immobilization in combination with high-level radioactive waste. To achieve a high degree of proliferation resistance, the National Academy of Sciences recommended that the national objective should be to make the surplus weapon-grade "plutonium roughly as inaccessible for weapons use as the much larger and growing quantity of plutonium that exists in spent fuel from commercial reactors," a state they defined as the *spent fuel standard*. This standard would require a form from which extraction and use in weapons of any residual plutonium and other fissile materials would be as difficult or unattractive as the recovery of residual plutonium from spent commercial fuel.

On March 1, 1995, approximately 200 metric tons 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 metric tons of other than weapon-grade plutonium that would be included in the disposition program.

Subsequently, the Department of Energy convened a team of laboratory, independent oversight and interagency experts to determine a range of reasonable disposition alternatives. Following a number of nationwide scoping meetings, the team released a screening report in March 1995 that pared 37 potential disposition options down to 11; five for reactor, four for immobilization and two for direct geologic disposal (deep borehole). The screening process led the Department to conclude that going beyond the spent fuel standard using advanced technologies, such as fast reactors and accelerators, was not appropriate. Such advanced options were found to require substantial additional research and development, with related increased costs and time, in order to provide the same assurance of technical viability as other, more readily available technologies.

At the April 1996 Moscow Nuclear Safety Summit, the leaders of the seven largest industrial countries and the Russian Federation issued a joint statement endorsing the need to render the surplus fissile materials (both highly enriched uranium and plutonium) in Russia and the United States to a high degree of proliferation resistance. Subsequently, former Russian President Yeltsin declared up to 50 metric tons of plutonium and 500 metric tons of highly enriched uranium as surplus to Russia's defense needs in September 1997.

Following the preparation of a Programmatic Environmental Impact Statement which evaluated various storage and disposition options, DOE issued a Record of Decision (ROD). In the 1997 ROD, 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 Savannah River Site (SRS) in South Carolina, and continue the storage of weapons-usable HEU 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 in Colorado would be moved to Pantex and SRS. Plutonium stored at the Hanford Site, the Idaho National Engineering and Environmental Laboratory (INEEL), and the Los Alamos National Laboratory (LANL) would remain at those sites until disposition (or moved to storage prior to disposition). In accordance with the ROD, DOE would provide 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 July 1998, the Department issued a draft *Surplus Plutonium Disposition Environmental Impact Statement (SPD EIS)* which analyzed candidate sites for plutonium disposition. The environmental consequences of siting, constructing, operating, and ultimately decommissioning the facilities under consideration for the plutonium disposition mission at one or more of four DOE sites was described in the draft SPD EIS issued in July 1998. In addition to assessing the environmental consequences of the disposition alternatives, DOE analyzed the cost and schedule differences between alternatives, taking into account information obtained during site visits, similar nuclear/industrial project costs, informal vendor quotations, previous estimates for similar equipment, parametric cost models, site-specific labor rates, and operational staffing requirements and salaries. A cost report was issued in July 1998 that focused on the differences in cost for siting the facilities at the different locations. In September 1998, at the Clinton-Yeltsin Summit, the two leaders committed their countries to enter into a bilateral plutonium disposition agreement.

In April 1999, DOE issued a Supplement to the draft SPD EIS, to address, among other things, impacts at the specific reactor sites which were identified pursuant to the contract with DOE's newly selected MOX contractor. In November 1999, DOE issued the *Surplus Plutonium Disposition Final Environmental Impact Statement.* This follow-on EIS evaluated the environmental impacts of conducting plutonium disposition activities at the following DOE locations: Hanford, Savannah River, Idaho National Engineering and Environmental Laboratory (INEEL) and the Pantex Plant. This was followed, in January 2000, by a decision that: the Pit Disassembly and Conversion Facility, the Mixed

Oxide Fuel Fabrication Facility, and the Plutonium Immobilization Facility would be located at SRS; up to 33 MT of plutonium would be fabricated as mixed oxide fuel at the Savannah River Site; and up to 17 MT of plutonium would be immobilized at the Savannah River Site.[8] The Department 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.

Also in November 1999, DOE issued an additional cost report, Plutonium Disposition Life-Cycle Costs and Cost-Related Comment Resolution Document, which provided the full life-cycle costs for the Preferred Alternative as stated in the draft SPD EIS.

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 metric tons 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. The review considered more than 40 approaches for plutonium disposition, with 12 distinct options selected for detailed analysis (six MOX-based reactor disposition options, two advanced reactor disposition options, and four non-reactor options (immobilization and long-term storage). This resulted in a refined approach under which the U.S. would rely on the irradiation of MOX fuel to dispose of surplus plutonium. After preparation of a Supplemental Aalysis pursuant to the National Environmental Policy Act, the Department issued an amended Record of Decision which, among other things, cancelled immobilization. Under the new approach, 34 MT of surplus plutonium would be fabricated into MOX fuel, including approximately 6.5 metric tons of impure plutonium previously destined for immobilization.

In 2006, DOE again evaluated its strategy for disposing of currently identified surplus weapons-usable plutonium, plus 26 MT of surplus highly enriched uranium for which viable disposition paths had not been identified. DOE's 2006 report titled, *Disposition of Surplus U.S. Materials, Comparative Analysis of Alternative Approaches* showed that all of the "going forward" various alternatives were within a few percentages of each other (in constant 2006 dollars), illustrating that monetary cost was not a major discriminating factor. In the case of storage, DOE would still have to incur the cost of disposition at the conclusion of the storage mission.

In March 2007, the Department also submitted to Congress a report titled, *Business Case Analysis of the Current U.S. Mixed Oxide (MOX) Fuel Strategy for Dispositioning 34 Metric Tons of Surplus Weapon-Grade Plutonium*, which included a business case rollup of going forward costs (in constant 2006 dollars) of various disposition alternatives. This report reconfirmed that the MOX approach was the most suitable

[8] About 4 MT of the 17 MT has been subsequently designated for programmatic use.

disposition alternative and showed that continued storage was the most expensive alternative over time.

DESCRIPTION OF DOE'S SURPLUS FISSILE MATERIALS

In accordance with the U.S.-Russia Plutonium Management and Disposition Agreement, the MOX facility will fabricate at least 34 MT of surplus weapon-grade plutonium into MOX fuel for subsequent irradiation in existing commercial reactors. The majority of the material is comprised of surplus pits, clean plutonium metal, and clean oxide (approximately 25.6 MT). The remaining quantity of plutonium is comprised of weapon-grade oxides that are acceptable to the MOX process and from future weapons dismantlements. Some of the metal and oxides are impure, and until physical sampling, analysis and characterization can be performed on individual cans containing this material, the final quantities could vary. Based on currently available information, the 34 MT of weapon-grade plutonium is comprised of the following:

- 25.6 MT of surplus plutonium pits, clean metal, and clean oxide;
- Approximately 4 MT of other metal and oxide; and
- Approximately 4.4 MT from future declarations of additional surplus pits.

In August 2006, DOE identified a small-scale plutonium vitrification process that could be used to dispose of up to 13 MT of plutonium. This 13 MT includes 4 MT of other metal and oxide that DOE currently believes are suitable for MOX and approximately 2 MT that is currently planned to be processed in the H-Canyon facility.

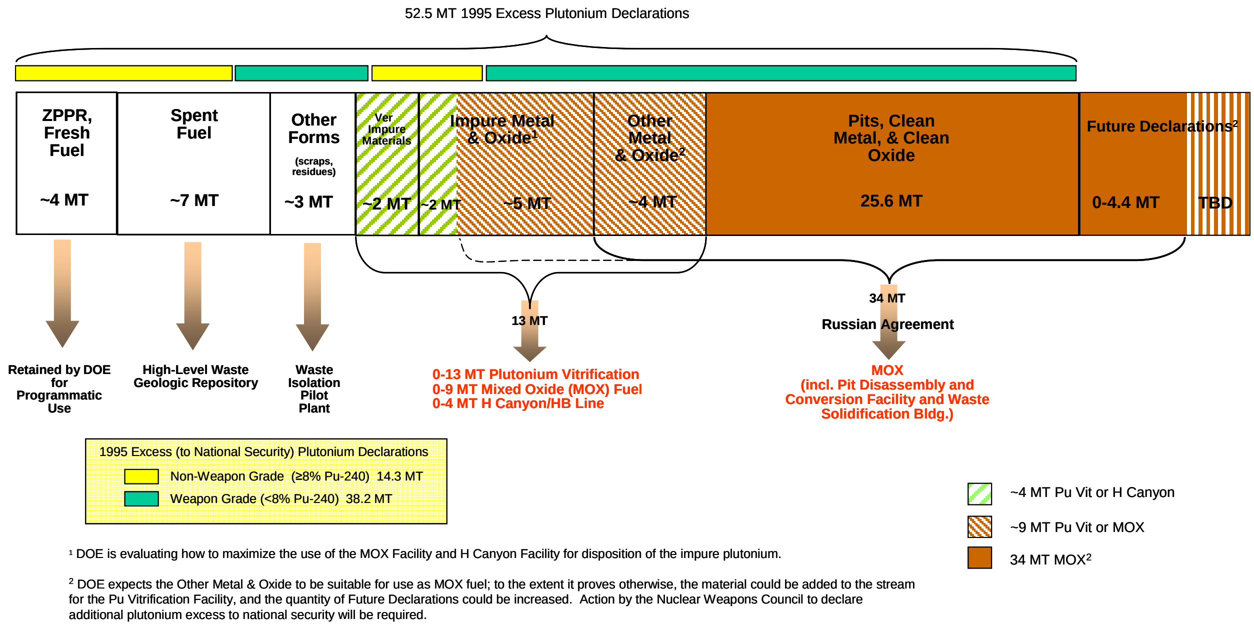
Based on currently available information, the 13 MT of plutonium is proposed to be distributed among the three facilities (MOX, the proposed small-scale Plutonium Vitrification process, and H-Canyon) based on the following material characteristics:

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 Facility	**~5 MT**[9]	-	**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[10]	-	**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

DOE will evaluate how to maximize the use of the MOX Facility for disposition of the non-pit plutonium currently being considered for the proposed small-scale Plutonium Vitrification process which is in the very early stages of design (less than 5% complete). DOE will continue to address technical and cost uncertainties as part of the Conceptual Design process and will arrive at a decision as to the need for the Plutonium Vitrification project as part of Critical Decision-1, planned for late 2007. The following is a graphical presentation showing the potential pathways for disposing of 52.5 MT of U.S. weapons-usable plutonium, which was declared surplus in 1995 (including spent fuel and fresh fuel retained for programmatic use), as well as plutonium which may be declared surplus in the future:

[9] As discussed elsewhere in this analysis, some or all of this material may be fabricated into MOX fuel in the MOX facility.
[10] As discussed elsewhere in this analysis, some of this material may be processed in H-Canyon.

Pathways for Disposing of U.S. Excess Plutonium



FINANCIAL ANALYSIS OF DOE'S PROPOSED BASELINE PLUTONIUM DISPOSITION APPROACH

DOE's proposed baseline approach includes a MOX Fuel Fabrication Facility, a Pit Disassembly and Conversion Facility (PDCF), and a Waste Solidification Building (WSB) to dispose of 34 MT of weapon-grade plutonium; a proposed Plutonium Vitrification process in the basement level of the K-Reactor Building to vitrify an expected 7 MT of non-pit plutonium (but potentially up to 13 MT of non-pit plutonium) currently unsuitable for fabrication into MOX fuel; and the H-Canyon/HB-Line facilities to process approximately 2 MT of plutonium bearing materials at the Savannah River Site to recover enriched uranium for subsequent down-blending and sale.

DOE uses a discounted cash flow analysis (or DCF) as the basis for its Business Case which takes into account the time value of money. The DCF method determines the present value of future cash flows by discounting them to the present using the U.S. Government's appropriate discount rate, as prescribed by OMB. This is necessary because cash flows (project related cost outflows and revenue stream inflows from the sale of MOX fuel and down-blended low enriched uranium) occur in different time periods. This approach is consistent with the information used previously in DOE's 2006 report entitled, *Disposition of Surplus U.S. Materials, Comparative Analysis of Alternative Approaches*, and with DOE's 2007 *Business Case Analysis of the Current U.S. Mixed Oxide (MOX) Fuel Strategy for Dispositioning 34 Metric Tons of Surplus Weapon-Grade Plutonium*, although those reports do not discount future cash flows.

The underlying conditions of the economic analysis are as follows:

- The analysis is based on estimates published previously in DOE/NNSA budget documentation (updated, where appropriate) and on the approved, externally reviewed and validated MOX total project cost baseline. The analysis did not independently develop or verify any of those estimates.
- Revenues from the sale of MOX reactor fuel and uranium from dismantled pits are included, where applicable.
- All cash flows represent relevant differences in expected current and future costs and revenues among the alternatives. Previous sunk costs are not considered.
- The net present value costs are in discounted 2006 dollars.
- The common time period is 2007 through 2034 and therefore includes current year expenditures.
- The discount rate (representing the Government's time value of money) is 3 percent, as prescribed in OMB Circular A-94.

The "going forward" cost, in net present value terms and excluding sunk costs, of DOE's proposed baseline approach is approximately $11.1 billion. A detailed analysis and assumptions follow:

Net Present Value Cost to DOE Over a 28-Year Period MOX, Vitrification and H-Canyon Operations (Millions of Dollars)	
Cost Element	**Net Present Value Cost**
MOX	$3,402
PDCF	$2,214
WSB	$544
Other Plutonium Disposition Costs[11]	$333
Vitrification	$797
H-Canyon	$340
Storage	$3,426
Net Present Value	$11,056

[11] Includes estimated costs associated with reactor modifications, reactor irradiation services, procurement of uranium feed materials, and fuel qualification.

MOX, Plutonium Disposition, H-Canyon Operations
Millions of Dollars
(Constant 2006 $)

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
		FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**	**FY31**	**FY32**	**FY33**	**FY34**
Real discount rate	3%																												
MOX Plant (34 MT)																													
Capital costs (TPC)		254	358	421	391	321	325	448	261	154	62																		
Operating costs (OPEX)											183	183	183	183	183	183	183	183	183	183	183	183	183	183					
Revenue (Value of MOX fuel to gov't)											-50	-105	-105	-105	-105	-105	-105	-105	-105	-105	-105	-105	-105	-105	-65				
Deactivation																										46			
Post-deact surv & mon w/term value																											6	6	206
Total annual cash flows		254	358	421	391	321	325	448	261	154	195	78	78	78	78	78	78	78	78	78	78	78	78	78	-65	46	6	6	206
Net present value	**$3,402**																												
PDCF (see above)																													
Capital costs (TPC)		42	49	62	154	225	257	389	365	304	191	173	127																
Operating costs (OPEX)		10	11	18	16	16	17	18						111	102	101	101	101	101	101	52								
Revenue (Value of LEU fuel to gov't)														-100	-100	-100	-100	-100	-100	-100									
Deactivation																						28							
Post-deact surv & mon w/term value																							10	10	10	10	10	10	343.3
Total annual cash flows		52	60	80	170	242	274	407	365	304	191	173	127	11	2	1	1	1	1	1	52	28	10	10	10	10	10	10	343
Net present value	**$2,214**																												
WSB (see above)																													
Captial costs																													
Capital coss TEC Costs		15.5	18.8	40	48	62.9	8.2																						
OPC Costs		4.5	3.9	4.2	8.3	12.2	6.2	3																					
Operating costs (OPEX)						4.2	20.4	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5					
Deactivation																									15				
Post-deact surv & mon w/term value																										1.5	1.5	1.5	51.5
Total annual cash flows		20	22.7	44.2	56.3	79.3	34.8	28.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	15	1.5	1.5	1.5	51.5
Net present value	**$544**																												
Other MOX Program Costs																													
Total annual cash flows		14.3	15.12	13.17	24.75	39.99	32.3	42.21	40.2	28.62	27.1	20.6	14.6	13.1	20.6	14.5	7.38	7.41	7.38	7.39	7.39	7.43	7.41	7.389	7.4	7.4	7.4		
Net present value	**$333**																												
Vitrification (7 MT)																													
Capital costs																													
Conceptual Design		10																											
TEC Costs			15	40	153	100	100	22																					
OPC Costs				10	9	9	10	20																					
Operating costs (OPEX)								40	75	75	75	75	75	75															
Total annual cash flows		10	15	50	162	109	110	82	75	75	75	75	75	75	0	0	0												
Net present value	**$797**																												
H Canyon (2 MT)																													
Operations (With Other Missions)		30	35	35	35	65	65	65	65																				
Total annual cash flows		30	35	35	35	65	65	65	65																				
Net present value (With Other Missions)	**$340**																												
Operations (Without Other Missions)		220	220	220	220	220	220	220	220																				
Total annual cash flows		220	220	220	220	220	220	220	220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net present value (Without Other Missions)	**$1,544**																												
Storage Costs (43 MT)																													
Hanford		90	75	68																									
KAMS - SRS																													
Operations		83	90	90	90	90	90	90	90	90	90	90	90	90															
S&S		56.9	56.9	56.9	56.9	56.9	56.9	56.9	56.9	56.9	56.9	56.9	56.9	56.9															
Pantex operating (w/term value)		16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	549.3
Pantex mod							10	46	46																				
LLNL		58	58	58	58	58	58	58	58																				
LANL		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50												
Total annual cash flows		353.9	345.9	338.9	270.9	270.9	280.9	316.9	317	212.9	213	213	213	213	66	66	66	16	16	16	16	16	16	16	16	16	16	16	549.3
Net present value	**$3,426**																												

Assumptions:

(1) MOX construction begins August 1, 2007; the facility becomes operational in 2016 and operates through 2029.

(2) PDCF becomes operational in 2019 and operates through 2026.

(3) WSB becomes operational in 2013 and operates through 2029.

(4) Proposed Plutonium Vitrification process becomes operational in 2013 and operates through 2019.

(5) For surplus non-pit plutonium, approximately 2 MT is processed through H-Canyon/HB-Line, approximately 4 MT is processed through the MOX facility, and the remaining 7 MT is vitrified in the proposed Plutonium Vitrification process.

(6) All cash flows are represented in 2006 (real) dollars.

(7) Consolidation of surplus, non-pit plutonium to SRS begins in 2007 and is completed in 2009.

(8) H-Canyon/HB-Line are maintained as a safeguards Category II facility.

(9) The primary mission for H-Canyon/HB-Line is to process aluminum clad spent fuel and recover enriched uranium, which continues through 2019. The costs associated with the "with other missions" are the costs attributable to operating the facility for processing plutonium whereas the costs associated with the "without other missions" are the costs to operate the facility if the plutonium mission carries the full costs of facility operations. The numbers are derived from the actual annual operating costs.

(10) The MOX total project cost is based on the current approved project baseline ($4.8 billion). <u>Note</u>: The Revised Continuing Appropriations Resolution, 2007 (P.L. 110-5) provides that the Secretary of Energy may not make available funds for construction activities for the MOX facility until August 1, 2007. This delay results in an increase to the MOX total project cost which is included in the net present value calculations.

(11) The project cost for PDCF and WSB is based on the project data sheet in the FY 2008 President's Budget.

(12) The project costs for Plutonium Vitrification are based on the pre-conceptual cost range approved at CD-0, and are the same as those appearing in the FY 2008 President's Budget.

(13) Costs for all storage facilities are based on actual operating costs and/or those costs projected by each of the sites.

(14) Storage costs for LLNL and LANL continue until programmatic materials are removed consistent with Complex 2030 goals in the years 2014 and 2022 respectively. Pantex storage costs continue due to continued storage of programmatic material. Storage costs are based on the total, actual operating costs of the storage facilities for both surplus and non-surplus programmatic materials. These costs include security costs and the required staffing to operate and maintain a Category 1 Security facility. Such costs are incurred regardless of the quantity of materials stored in the facility and would be incurred so long as surplus or programmatic materials are stored at the facilities. The facilities at Pantex, LLNL, and LANL contain both programmatic and surplus materials and accordingly, storage costs would be incurred until all of the materials (surplus and programmatic) have been removed. For these reasons, it is not appropriate to allocate incremental storage costs for only surplus plutonium.

(15) The estimated nearer-term plutonium storage costs of $3.4 billion represent the storage costs to the Department until removal of surplus plutonium from Hanford, LLNL, and LANL pursuant to DOE's Complex 2030 and material consolidation goals. If consolidation of the surplus plutonium does not proceed and the materials continue to be

stored at present locations, then an incremental storage cost of approximately $6 billion would be incurred, in addition to the future cost to dispose of the materials at a later time. Storage (without disposition) would be the most expensive option because the discounted (net present value) storage costs are within 10% of the proposed baseline approach and do not account for the additional cost to dispose of the material.

(16) The net present value costs are consistent with the information used previously in DOE's 2006 report entitled, Disposition of Surplus U.S. Materials, Comparative Analysis of Alternative Approaches, and with DOE's 2007 Business Case Analysis of the Current U.S. Mixed Oxide (MOX) Fuel Strategy for Dispositioning 34 Metric Tons of Surplus Weapon-Grade Plutonium, but differ in that: (1) the earlier studies did not discount the costs, and (2) the earlier studies analyzed the combined plutonium and uranium storage costs in lieu of the plutonium storage cost as described in this study. If DOE continues to store surplus materials at Hanford, LANL, and LLNL, cost savings from removing plutonium pursuant with Complex 2030 initiative and materials consolidation would not be realized.

(17) Costs are included for construction of six magazines to increase storage efficiency for surplus pits in Zone 4 at Pantex.

(18) Costs of operating H-Canyon/HB-Line without other missions represent the total cost of operating H-Canyon/HB-Line and are based on actual annual operating costs. This scenario would occur if other planned missions do not take place and H-Canyon/HB-Line was operated solely for plutonium disposition.

(19) Revenues from the sale of MOX fuel and the uranium from dismantled pits are based on the price of uranium as of November 2006.

(20) A terminal value is used to assign an equivalent financial value to those activities assumed to continue indefinitely, such as storage and surveillance and monitoring.

EVALUATION OF ALTERNATIVE STORAGE AND DISPOSITION APPROACHES

The following section compares the Department's proposed baseline approach with other storage and disposition approaches on the basis of nonproliferation aspects, institutional factors, technical maturity and technical uncertainty, and cost and schedule considerations. Plutonium disposition approaches are grouped into two distinct categories. Those approaches in the first category meet U.S. national security and nonproliferation objectives concerning the disposition of surplus plutonium by rendering it unusable for nuclear weapons, and encourage Russia to dispose of its surplus weapons plutonium. Specific approaches in this category include: DOE's proposed Baseline Approach (MOX, the proposed small-scale Plutonium Vitrification process and H-Canyon/HB-Line) and Maximize Utilization of MOX and H-Canyon/HB-Line. The second category contains those approaches that fail to accomplish these objectives and include: large-scale (41 MT) Immobilization Facility and H-Canyon, Consolidate and Vitrify (~ 13 MT) Non-Pit Plutonium at SRS While Continuing to Store Surplus Pits at Pantex, Consolidate the Storage of Non-Pit Plutonium (~ 13 MT) at SRS and Store Surplus Plutonium (~43 MT) In-Place at Current Locations.

APPROACHES THAT MEET U.S. NATIONAL SECURITY AND NONPROLIFERATION OBJECTIVES

Proposed Baseline Approach (MOX, Plutonium Vitrification and H-Canyon): The proposed baseline approach consists of: (1) construct and operate a MOX Fuel Fabrication

Facility, a Pit Disassembly and Conversion Facility, and a Waste Solidification Building to dispose of 34 MT of weapon-grade plutonium; (2) design, construct and operate a plutonium vitrification process in the basement level of the K-Reactor Building to vitrify up to 13 MT of non-pit plutonium; and (3) operate the existing H-Canyon/HB-Line facilities to process approximately 2 MT of very impure plutonium bearing materials at the Savannah River Site, along with the mission to recover enriched uranium for subsequent down blending and sale.

DOE's proposed baseline approach for disposing of surplus plutonium meets all of the programmatic objectives. The detailed design of the MOX facility is about 90% complete, and the technology has been in use throughout Europe for three decades. The proposed Plutonium Vitrification process, on the other hand, is in the very early stages of design (less than 5% complete). As such, there remains uncertainty associated with the design and cost estimates and therefore, future cost growth is likely. DOE will continue to address technical and cost uncertainties as part of the Conceptual Design process. The MOX fuel fabrication facility, once operational, could potentially provide the following capabilities: disposition of additional plutonium from future weapons dismantlement, if declared surplus; possible fabrication of start-up fuel for GNEP fast reactors depending on fuel form selected and the 2008 determination of the GNEP path forward by the Secretary of Energy; and disposition of additional surplus impure plutonium (currently planned for Plutonium Vitrification), if the chemical and isotopic impurities can be economically removed from the material. This approach will incur additional costs if there is delay in pursuing the currently planned program.

Maximize Utilization of MOX and Operate H-Canyon (MOX and H-Canyon): Construct and operate a MOX Fuel Fabrication Facility, a Pit Disassembly and Conversion Facility, and a Waste Solidification Building to dispose of approximately 39 MT of weapon-grade and fuel-grade plutonium, and to operate the existing H-Canyon/HB-Line facilities to process approximately 4 MT of certain impure and very impure plutonium bearing materials at the Savannah River Site, together with the mission to recover enriched uranium for subsequent down blending and sale.

As with the proposed baseline approach, this approach meets all of the programmatic objectives. Overall, it has the highest degree of technical maturity and is therefore likely to have the least unplanned programmatic cost growth. The proposed small-scale Plutonium Vitrification process is in the very early stages of design (less than 5% complete). As such, there remains uncertainty associated with the design and cost estimates and therefore, future cost growth is likely. DOE will continue to address technical and cost uncertainties as part of the Conceptual Design process. Engineers are currently evaluating the cost and technical feasibility of maximizing the use of the MOX facility and reducing the mission that is currently proposed for the small-scale Plutonium Vitrification process. If feasible, it could permit DOE to use MOX and H-Canyon to dispose of the approximately 43 metric tons of surplus plutonium. Preliminary indications are that this approach may result in cost savings of approximately $500 million (estimated total project cost in constant 2006 dollars, excluding operating costs) when compared to the proposed baseline approach, although actual savings may change as the design of the small-scale Vitrification process progresses. Moreover, this approach would require minor modifications to the H-Canyon. As mentioned above, the MOX fuel fabrication facility, once operational, could potentially provide the following capabilities: disposition of additional plutonium from future weapons dismantlement, if declared surplus; and possible fabrication of start-up fuel for GNEP fast reactors depending on a decision by the Secretary of Energy on the scope of the GNEP program scheduled for June 2008.

APPROACHES THAT FAIL TO MEET U.S. NATIONAL SECURITY AND NONPROLIFERATION OBJECTIVES

Immobilization Facility and H-Canyon: Under this approach, DOE would design, construct, and operate a new, large-scale (approximately 41 MT) stand-alone Plutonium Immobilization Plant (using ceramification technology, since immobilization of such a large amount of plutonium would not be feasible using vitrification in a borosilicate glass due to the high radiation levels produced). A Pit Disassembly and Conversion Facility would be needed to take apart nuclear weapons cores and convert the resulting plutonium metal to an oxide form for ceramification as would a Waste Solidification Building. Operation of the existing H-Canyon/HB-Line facilities would be used to process approximately 2 MT of plutonium bearing materials at the Savannah River Site, together with the mission to recover enriched uranium for subsequent down blending and sale.

This approach is likely to be seen by Russia as being inconsistent with the U.S.-Russia Plutonium Management and Disposition Agreement and is unlikely to encourage Russia to dispose of its surplus weapon-grade plutonium. Russia continues to view immobilization as another form of storage because it does not degrade the isotopics of the weapon-grade plutonium as would irradiation in a nuclear reactor. Therefore, Russia continues to believe that weapon-grade plutonium from the immobilized waste form could be retrieved for use in new nuclear weapons. This approach does support the program objectives of consolidating and disposing surplus plutonium in support of Complex 2030 and related DOE goals. Plutonium immobilization maintains the commitment to U.S. nonproliferation goals by potentially dispositioning 43 MT of plutonium in an intrinsically theft resistant form. The ability to complete the 41 MT immobilization mission with high level waste located at the Savannah River Site is not possible, however, because of an insufficient quantity of high level waste needed to fill the waste canisters, in order to provide an intrinsically self protecting theft-resistant form. Immobilization[12] of plutonium in a ceramic matrix also has a high degree of technical uncertainty because of the relatively low technical maturity associated with this technology. As a result, substantial future cost growth to accomplish plutonium immobilization is likely, and the overall programmatic cost is expected to be greater than DOE's current planned baseline program. In addition, significant program delays are likely because of the currently low technical maturity of this option, coupled with required new evaluations associated with such a major program change (e.g., extensive research and development, facility design and construction are likely to mean that an Immobilization Facility could not become operational for an additional 12−14 years).

Consolidate and Vitrify Non-Pit Plutonium at SRS and Continue to Store Pits at Pantex: Design, construct and operate a Plutonium Vitrification process in the basement level of the K-Reactor Building to vitrify up to 13 MT of non-pit plutonium; operate the existing

[12] Immobilization of plutonium in a ceramic form has never been done before and designs for an immobilization facility do not exist. This approach would require extensive research and development followed by a detailed engineering effort to design an immobilization facility. This approach is likely to take between 10 – 12 years before construction can begin and result in significant cost increases and schedule delays.

H-Canyon/HB-Line facilities to process approximately 2 MT (included in the preceding 13 MT) of plutonium bearing materials at the Savannah River Site, with the mission to recover enriched uranium for subsequent down blending and sale, and continue to store DOE's inventory of surplus pits at Pantex.

This alternative approach would result in the disposition of approximately 13 MT of mostly non-weapon-grade plutonium but leaves thousands of surplus nuclear weapon pits in storage at Pantex. Thus, this approach does not meet U.S. national security and nonproliferation objectives with respect to rendering DOE's entire inventory of surplus plutonium unusable for future weapons use and does not encourage Russia to dispose of its surplus weapons plutonium. Upgrades would be needed at Pantex to continue to store the surplus nuclear weapons pits. As stated previously, the proposed small-scale Plutonium Vitrification process is in the very early stages of design (less than 5% complete). As such, there remains uncertainty associated with the design and cost estimates and therefore, future cost growth is likely.

Consolidate the Storage of Non-Pit Plutonium at SRS: Under this approach, DOE would: consolidate the storage of up to 13 MT of non-pit plutonium from Hanford, Los Alamos National Laboratory and Lawrence Livermore National Laboratory at SRS; continue to operate the existing H-Canyon/HB-Line facilities to process approximately 2 MT of plutonium bearing materials together with the mission to recover enriched uranium for subsequent down blending and sale; and continue to store indefinitely DOE's inventory of surplus nuclear weapons pits at Pantex.

This alternative approach would not meet U.S. national security and nonproliferation objectives with regard to disposing of 43 MT of surplus plutonium by rendering it unusable for nuclear weapons use and would not encourage Russia to dispose of its surplus weapons plutonium. Since it would also fail to provide a disposition pathway out of the Savannah River Site for surplus plutonium brought there for disposition, existing law currently prohibits the further shipment of this plutonium to SRS under certain circumstances to achieve consolidation. This approach would not prevent the accumulation of stockpiles of surplus plutonium, deferring final disposition decisions and costs until the future. Upgrades would still be needed at Pantex to continue to store thousands of surplus nuclear weapons pits.

Store Surplus Plutonium In-Place at Current Locations: DOE would continue to store surplus plutonium at current locations, i.e., Savannah River Site, Pantex, Hanford, Los Alamos National Laboratory and Lawrence Livermore National Laboratory. Under this approach, the existing H-Canyon/HB-Line facilities would process approximately 2 MT of plutonium bearing materials already at the Savannah River Site, with the mission to recover enriched uranium for subsequent down blending and sale.

This alternative approach would not meet U.S. national security and nonproliferation objectives. It would not meet U.S. obligations under the 2000 U.S.-Russia Plutonium Management and Disposition Agreement and would not encourage Russia to dispose of its surplus weapons plutonium. This approach would defer final disposition decisions and costs until some time in the future. Storage costs, discounted to the present, are within approximately 10% of DOE's planned baseline disposition costs, over the equivalent time period.[13] At the conclusion of the storage period, DOE would still have to fund an expensive disposition program, or continue to pay storage costs.

Conclusion

DOE's proposed baseline approach for disposing of surplus plutonium (MOX, proposed small scale Plutonium Vitrification process, and H-Canyon) would meet U.S. national security and nonproliferation objectives for disposing of 43 MT of surplus plutonium by rendering it unusable for nuclear weapons use, and would provide the best chance of encouraging Russia to dispose of its surplus weapons plutonium. In addition, the proposed baseline approach would help reduce storage costs for nuclear materials, reduce safeguards and security costs, and support the Department's efforts to consolidate nuclear materials within the DOE Complex.

The detailed design of the MOX facility, a key element of the baseline approach, is about 90% complete, and the technology has been in use throughout Europe for three decades. The Nuclear Regulatory Commission (NRC) has authorized construction and DOE's contractor has submitted a license application to the NRC for operation of the MOX facility. In addition, MOX fuel lead assemblies, containing surplus weapons plutonium, are currently being successfully tested in a commercial nuclear reactor in South Carolina and the irradiation of MOX fuel will generate electricity through which revenues are produced for the U.S. Treasury. Moreover, the MOX fuel fabrication facility, once operational, could potentially provide the following capabilities: disposition of additional plutonium from future weapons dismantlement, if declared surplus; possible fabrication of start-up fuel for GNEP fast reactors depending on a decision by the Secretary of Energy on the scope of the GNEP program scheduled for June 2008; and disposition of additional surplus impure plutonium (currently planned for Plutonium Vitrification), if the chemical and isotopic impurities can be economically removed from the material.

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[13] The 2007 *Business Case Analysis of the Current U.S. Mixed Oxide (MOX) Fuel Strategy for Dispositioning 34 Metric Tons of Surplus Weapon-Grade Plutonium* showed that storage costs in constant 2006 dollars for 50 years of storage would be $15.45 billion and would exceed the base case costs.

Attachment 2
Proposed Plutonium Vitrification Process

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.

Attachment 3
Plutonium Disposition Alternatives

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	Analyzed in detail

		DWPF, stored in a GWSB, and ultimately shipped to a HLW repository.	
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 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, but the H-Canyon facilities	Analyzed in detail

		are maintained as Category II facilities.	
5C	Dissolution in H-Canyon to DWPF to HLW Repository (without 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. 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)

*PUBLIC LAW 109–103—NOV. 19, 2005. SEC. 309. None of the funds in this Act may be used to dispose of transuranic waste in the Waste Isolation Pilot Plant which contains concentrations of plutonium in excess of 20 percent by weight for the aggregate of any material category on the date of enactment of this Act, or is generated after such date. For the purpose of this section, the material categories of transuranic waste from the Rocky Flats Environmental Technology Site include: (1) ash residues; (2) salt residue; (3) wet residues; (4) direct repackage residues; and (5) scrub alloy as referenced in the ''Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site''.

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 and Dispose to HLW Repository With SNF	Plutonium is processed into a ceramic 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.	Screened out (Same 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)
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)