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Selection of Surplus Plutonium Materials for Disposition to WIPP

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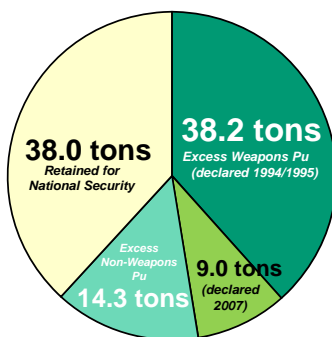
ABSTRACT

The U.S. Department of Energy (DOE) is preparing a Surplus Plutonium Disposition (SPD) Supplemental Environmental Impact Statement (SEIS). Included in the evaluation are up to 6 metric tons (MT) of plutonium in the form of impure oxides and metals for which a disposition plan has not been decided, among options that include preparation as feed for the Mixed Oxide Fuel Fabrication Facility; disposing to high-level waste through the Savannah River Site (SRS) HB Line and H Canyon; can-in-canister disposal using the SRS Defense Waste Processing Facility; and preparation for disposal at the Waste Isolation Pilot Plant (WIPP). DOE and SRS have identified at least 0.5 MT of plutonium that, because of high levels of chemical and isotopic impurities, is impractical for disposition by methods other than the WIPP pathway. Characteristics of these items and the disposition strategy are discussed.

BACKGROUND

The U.S. DOE, including the semiautonomous National Nuclear Security Administration (NNSA), is engaged in a program to disposition U.S. surplus weapons-usable plutonium. The U.S. has declared 61.5 MT of plutonium to be excess to potential use in nuclear weapons. Figure 1 shows the distribution of the 99.5 MT of U.S. Government plutonium that was tracked by materials control and accountability as of September 30, 1994.* Surplus plutonium is material that is excess to weapons activities and also has no programmatic need within the DOE.

Figure 1. Excess U.S. Plutonium



DOE and NNSA are preparing a *Surplus Plutonium Disposition Supplemental Environmental Impact Statement*¹ that describes plans for the permanent disposition of surplus plutonium. The

* These quantities do not include plutonium that was previously disposed to waste, or plutonium contained in irradiated fuel within the civilian power reactor sector. A significant fraction of the excess plutonium has been disposed since 1994 to support the deinventory of legacy facilities, including those at Rocky Flats and Hanford.

preferred alternative for the bulk of the material is fabrication into mixed oxide (MOX) fuel in the MOX Fuel Fabrication Facility (MFFF), currently under construction at SRS with full operations planned for 2017. This preferred alternative is in accordance with a Plutonium Management and Disposition Agreement (PMDA) between the U.S. and the Russian Federation for each Nation to dispose of 34 MT of weapons-grade plutonium.²

The SPD SEIS discusses options for the disposition of the 34 MT and additional material contained in the 61.5 MT. Figure 2 shows the framework of the support for the MOX program and options for disposition of plutonium that is not suitable for the MOX program. Figure 3 shows a breakdown of the inventories associated with the disposition program.

Figure 2. U.S. Plutonium Disposition Framework

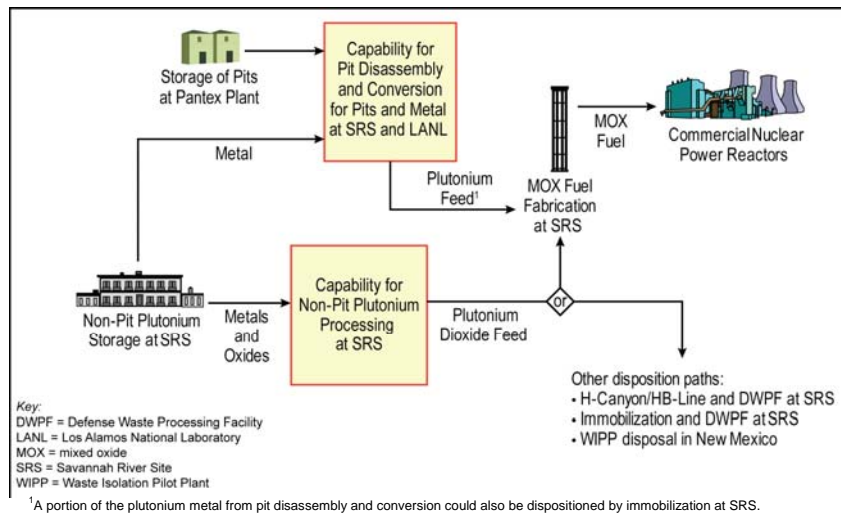
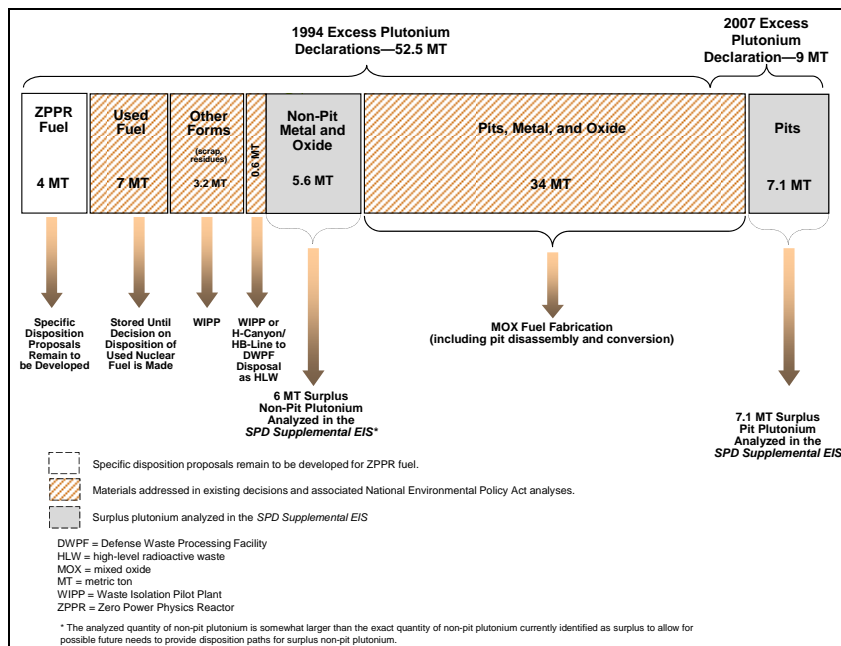


Figure 3. U.S. Plutonium Disposition Inventories



From the 62.5 MT of excess plutonium, at least 41.1 MT (at the right of the figure) is likely to prove suitable for MOX fuel fabrication. Other inventories include residues that have been disposed as transuranic (TRU) waste and plutonium contained in irradiated fuels. Approximately 6 MT with no defined disposition is addressed in the SPD SEIS. This material is considered unsuitable for MOX because of chemical impurities or because it is non-weapons-grade plutonium that falls outside the range allowed for the minimum of 34 MT for the PMDA.

Portions of this 6 MT may be suitable for conversion into MOX feed. DOE's preferred alternative for disposition of surplus plutonium that is not suitable for MOX fuel fabrication is disposal at the Waste Isolation Pilot Plant in New Mexico.

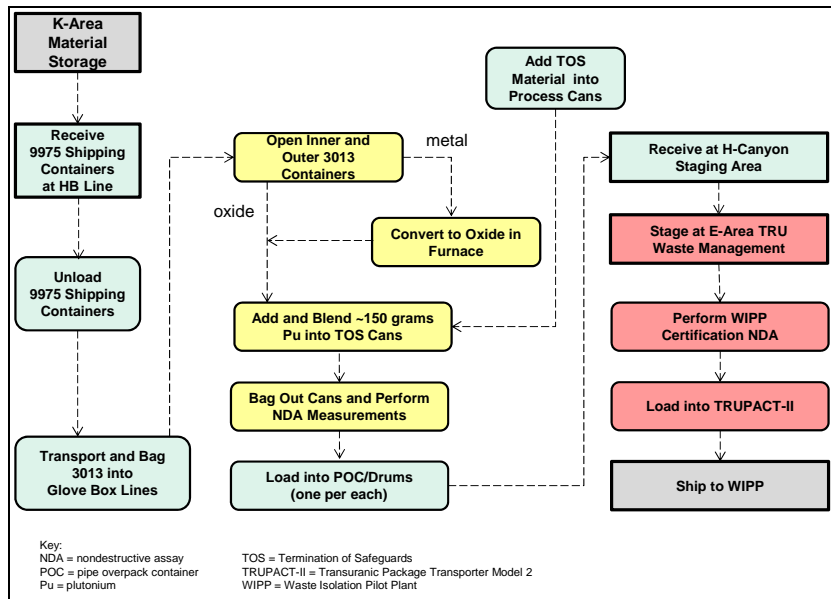
WIPP BLENDING OPERATION

Pending completion of the SPD SEIS, DOE concluded that at least 500 kilograms (kg) of the 6 MT is very unlikely to be suitable for conversion into MOX feed, and authorized SRS to begin preparing and shipping these non-pit plutonium materials to WIPP.³ DOE initiated a project to prepare material stored in SRS's K Area into a form that can be disposed as transuranic waste to WIPP.

The initial project will convert up to 85 kilograms of non-pit Pu that will be removed from storage containers through FY2012 as part of the Destructive Evaluation (DE) program of the Integrated Surveillance Program (ISP).^{4,5} DE is one technique used to demonstrate conformance of stored materials with the Standard for Long-Term Plutonium Storage, DOE-STD-3013.⁶

Once the demonstration is completed, the glovebox line will be available to process up to 200 kg/year of surplus Pu for disposal as TRU. Figure 4 shows the process flow for the WIPP Blending operation.

Figure 4. Processing Plutonium for Disposal as Transuranic Waste



Oxides are received from the SRS K-Area Material Storage facility into a glove box in HB-Line Phase I, subdivided, and mixed with filler material that will simultaneously dilute the plutonium below 10 wt.% and provide a matrix from which it would be difficult to extract the plutonium. Vulnerability Analyses show that the resulting mixture is suitable for Termination of Safeguards (TOS) when it is later packaged, subsequently stored, shipped, and emplaced at WIPP.

The mixture is bagged out and loaded into Pipe Overpack Containers (POCs), which are then stored in the E-Area Solid Waste Management facilities pending certification for disposal to WIPP and transportation in Transuranic Package Transporter Model 2 (TRUPACT-II) shipping casks.

If the SPD SEIS recommends additional disposal of surplus, non-MOXable, non-pit plutonium to WIPP, this glovebox would continue to operate. Depending on the quantity chosen for this disposition pathway, SRS may operate a single glovebox line for WIPP disposition (through approximately FY2031) or consider operation of additional glovebox lines. Non-pit plutonium metals that are processed in this manner will be introduced to the HB-Line glove box and thermally oxidized in air.

SRS experience in developing the blending demonstration and implementation for later production is proving valuable for other sites that are considering expanded disposition of plutonium-bearing materials as transuranic waste.

MATERIAL SELECTION

The major feeds to the first stage of operations were oxides from containers that were opened for sampling and analysis in the ISP Destructive Evaluation program. SRS expects to continue to dispose of DE oxides by this method through at least FY2014. Priorities are being developed for the processing of additional oxides recognized in the 500 kg of the Interim Action and other surplus plutonium material if the program is extended.

Selection will depend on a variety of factors, including potential utilization by the MOX Program.⁷ A few of the factors that could make portions of the inventory less attractive for disposal to WIPP include:

- *Weapons-Grade Plutonium Oxides with Halides:* SRS is developing a glovebox process using Vacuum Salt Distillation to remove chloride and fluoride impurities. Oxides treated by this method could meet MFFF requirements and provide a lower cost disposition alternative with nonproliferation benefits.
- *Pure Fuel-Grade Plutonium Oxides:* Selected plutonium oxides have high purity but are outside the "weapons grade" isotopic range for the MFFF. These items could be blended with plutonium derived from weapons components and converted into MOX fuel, but the plutonium would not be credited against the 34 MT target for the U.S.-Russian PMDA.
- *Potential Resource Value:* Selected items contain elevated concentrations of commercially important isotopes such as americium-241. Actinides in the current surplus inventory may also become attractive as feed material for proposed future fuel cycles.
- *Metal Form:* The WIPP Blending process uses plutonium oxide feed. Surplus metals must first be oxidized, a factor that could make other disposition options less costly or more attractive.

Conversely, the Interim Action recognizes that parts of the surplus plutonium inventory are poorly suited for other disposition options. A few of the factors that could make portions of the inventory more attractive for disposal to WIPP include:

- *Future Destructive Evaluation from Surveillance Program:* Containers that are opened and divided for DE are no longer packaged to the long-term storage Standard, and would need to be repackaged for interim storage. These items also are generally unattractive for MFFF or other use because of high impurity levels.
- *Containers with Corrosion Potential:* The ISP has not observed DOE-STD-3013 containers that are unlikely to meet the longevity goals of the Standard, but previous evaluations found oxide categories with specific processing histories that exhibit slow but measurable corrosion. Impure items with specific halide salts, borderline moisture-content measurements, or limited chemical data are a focus of Engineering Judgment selections for the DE program.
- *Impure Fuel-Grade Plutonium Oxide:* These items exhibit all negative characteristics discussed in the Interim Action: they have high levels of both chemical and isotopic impurities. They may be the least likely category to have an attractive alternative disposition pathway.
- *Very Impure Weapons-Grade Plutonium Oxide:* Even if no corrosion potential is evident, some of the surplus plutonium has very high levels of stable impurities, such as iron-nickel-chromium from contact with process equipment, or calcium or magnesium from early processing, much like residues that were disposed to WIPP from Rocky Flats using a similar method.
- *Plutonium with Depleted Uranium:* Some items, primarily of fuel-grade plutonium, hold high percentages of depleted or normal uranium. Processing may require fewer product containers per feed container because of the lower fissile content.
- *Inefficiently Stored Items:* Certain storage containers hold less mass than other storage containers. Early removal for processing for disposal to WIPP could improve efficiency in the K-Area Material Storage and free storage space for other missions.

Up to approximately 4 MT of surplus, non-pit plutonium could be evaluated for disposal with these methods. Priorities for the next several years, and for schedules in later years if the program is extended, will be set by recognizing the positive and negative factors for this pathway.

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