

Contract No:

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy.

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Progress in Reducing the Nuclear Threat: United States Plutonium Consolidation and Disposition

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ABSTRACT

Following the end of the Cold War, the United States identified 61.5 metric tons (MT) of plutonium and larger quantities of enriched uranium that are permanently excess to use in nuclear weapons programs. The Department of Energy (DOE) also began shutting down, stabilizing, and removing inventories from production facilities that were no longer needed to support weapons programs and non-weapons activities. The storage of "Category I" nuclear materials at Rocky Flats, Sandia National Laboratories, and several smaller sites has been terminated to reduce costs and safeguards risks. De-inventory continues at the Hanford site and the Lawrence Livermore National Laboratory. Consolidation of inventories works in concert with the permanent disposition of excess inventories, including several tonnes of plutonium that have already been disposed to waste repositories and the preparation for transfers to the planned Mixed Oxide (MOX) Fuel Fabrication Facility (for the bulk of the excess plutonium) and alternative disposition methods for material that cannot be used readily in the MOX fuel cycle. This report describes status of plutonium consolidation and disposition activities and their impacts on continuing operations, particularly at the Savannah River Site.

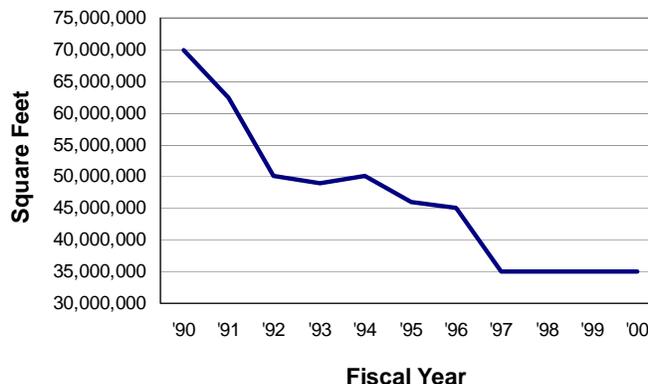
EVOLUTION OF THE DOE NUCLEAR MATERIALS COMPLEX

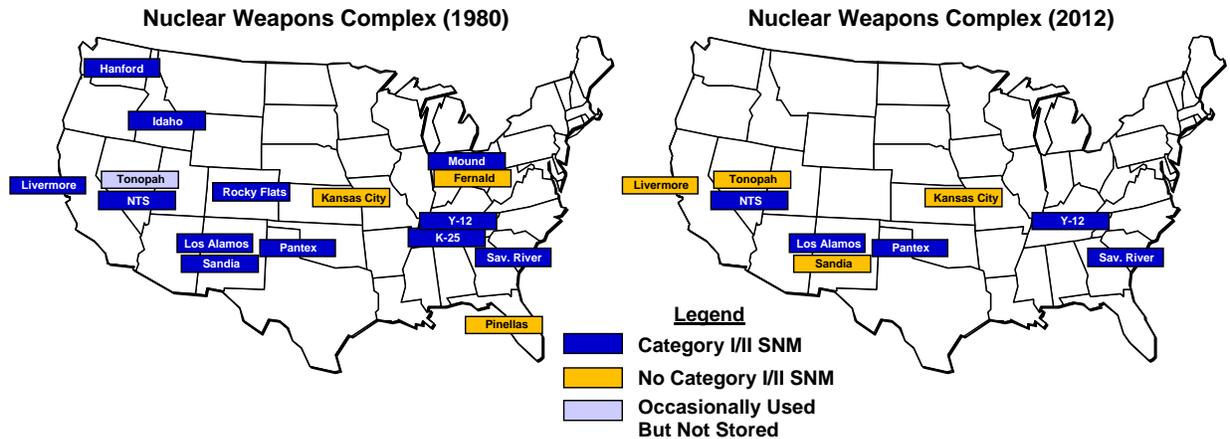
For more than 60 years, the DOE has produced, acquired, and maintained inventories of plutonium and uranium for nuclear weapons production and non-defense missions. The development, production, recycling, and manufacture of materials and components required an extensive infrastructure. With the end of the Cold War, a large portion of this infrastructure (and the special nuclear material [SNM] it managed, including plutonium [Pu] and highly enriched uranium [HEU]) was no longer needed to support the diminished military threats. In the post-Cold-War era, one emphasis of the complex shifted from "production" to "protection," with goals including:

- Support Stockpile Stewardship and Naval Reactor Programs
- Prevent the spread of Weapons of Mass Destruction or Effect
- Eliminate or secure excess nuclear materials
- De-militarize weapons-grade materials by use in civilian fuel cycles
- Close legacy facilities.

The size of the nuclear weapons complex declined by half in the 1990s and downsizing continues today.¹ In February 2008, Sandia National Laboratories completed the removal of Category I/II quantities of SNM, seven months ahead of schedule.² Lawrence Livermore National Laboratory (LLNL) will remove all Category I/II SNM from its facilities by 2012.

1990s Weapons Complex Footprint Reductions





Within sites, from 2004 through 2006, Los Alamos National Laboratory (LANL) removed Category I SNM from its TA-18 facility. A plan has been developed to remove material excess to future programmatic needs to support Defense Programs Transformation. At the same time, Los Alamos has assisted multiple DOE and civilian sites in deinventory of their nuclear materials.

The footprint reductions involved cooperation from diverse organizations inside and outside the DOE, including the National Nuclear Security Administration (NNSA). A key player has been the Office of the Office of Environmental Management (DOE-EM), established to remediate legacy sites and enable site closure or reuse.³ Key closure-site activities have included:

- Rocky Flats Environmental Technology Site
- Miamisburg Closure Project (Mound Plant)
- Fernald Materials Production Center
- East Tennessee Technology Park (K-25 Plant and related facilities)
- Ashtabula Closure Project
- Columbus Closure Project

Closure of the former Rocky Flats Plant site and its conversion into the Rocky Flats National Wildlife Refuge is possibly the most visible of the completed projects, but other closure projects have enabled significant long-term cost reductions for the DOE while stimulating regional economic growth or environmental improvements.

As mission requirements have evolved, portions of other sites that managed nuclear materials are closed or modified for alternative uses, including sites within:

- Idaho National Laboratory
- Hanford Reservation and Office of River Protection
- Savannah River Site
- Oak Ridge Site
- Separations Process Research Unit (Knolls Atomic Power Laboratory)
- Brookhaven Graphite Research Reactor (Brookhaven National Laboratory)
- Energy Technology Engineering Center (Santa Susana Field Laboratory)
- Inhalation Toxicology Laboratory (Lovelace Institute)
- Moab, Utah UMTRA Project
- Stanford Linear Accelerator Center
- West Valley Demonstration Project

OTHER MATERIALS CONSOLIDATION INITIATIVES

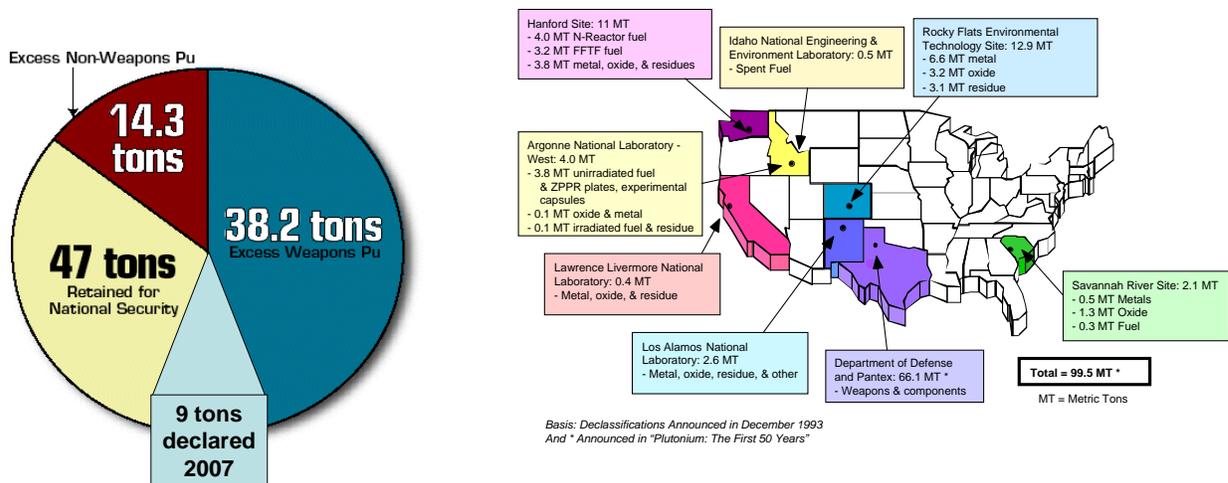
Providing increased security for nuclear materials is not confined to the Category I/II SNM that is often the focus of "consolidation" discussions. Smaller quantities of materials are distributed throughout government, industry, agriculture, and education, primarily as sealed sources, standards, and research materials. Securing and protecting excess or unwanted items contributes to increased protection against their diversion, particularly for potential use in Radiation Dispersion Devices (including "dirty bombs"). Significant successes include two initiatives sponsored by the NNSA's Office of Nuclear Nonproliferation, Global Threat Reduction Initiative (GTRI):

- Domestically, the Offsite Source Recovery, centered at Los Alamos and coordinated with Idaho National Laboratory, has recovered more than 20,000 excess sealed radioactive sources, made from plutonium, cesium, americium, cobalt, strontium, and other materials.
- Overseas, GTRI is partnered with most nations of the world, and has removed or assisted in the removal of nuclear materials from 50 countries and in protecting nuclear and radiological materials in more than 110 countries. Similar programs are underway under sponsorship of the Russian Federation.⁴

BULK PLUTONIUM SUBJECT TO DISPOSITION

For bulk SNM, former President Clinton issued a Nonproliferation and Export Control Policy with the framework for U.S. efforts to prevent the proliferation of weapons of mass destruction. A key element of the President's policy was a U.S. commitment to eliminating, where possible, the accumulation of stockpiles of HEU and Pu and to ensure that – where these materials already exist – they are subject to the highest standards of safety, security, and international accountability.

In 1995, the United States declared more than 200 MT of fissile material, including 38.2 MT of weapons-grade Pu and 174 MT of HEU, to never again be used to build nuclear weapons. Additionally, 14.3 MT of non-weapons-grade Pu was identified as excess to weapons requirements. In 2005 and 2007, respectively, the Bush Administration removed another 200 MT of HEU and 9 MT of Pu from weapons programs. U.S. government-managed plutonium is summarized below.



The Savannah River Site (SRS) is designated as the primary site for disposition of surplus plutonium. Plutonium components ("pits") will be converted to oxide in the Pit Disassembly and Conversion Facility (PDCF), then transferred to the MFFF. Pits are assumed to be stored at the Pantex Plant until they are required by PDCF for processing. Other materials will be consolidated at Savannah River prior to disposition processing.

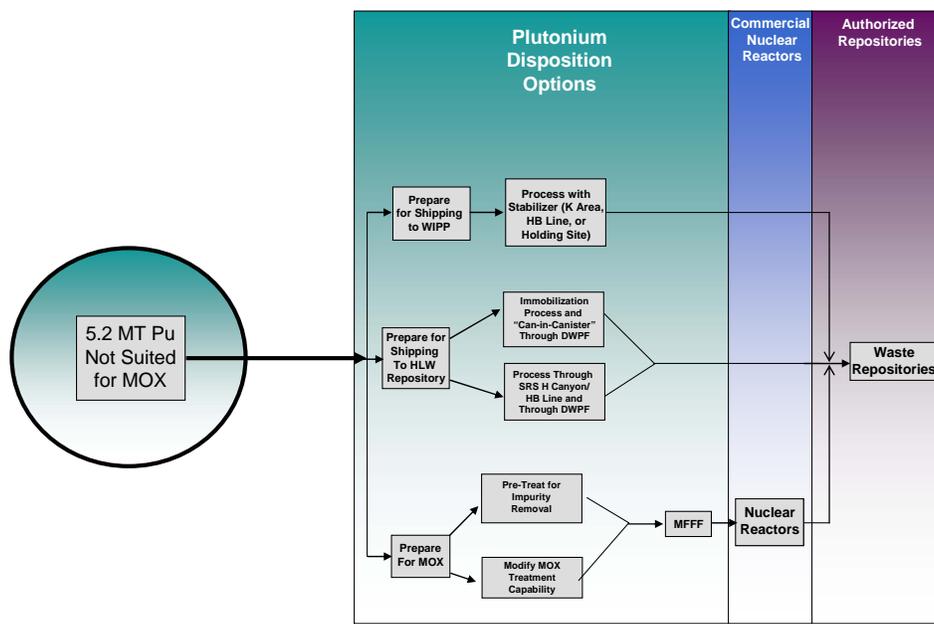
Disposition discussions have focused on the management of the excess plutonium that requires new facilities and capabilities. However, a significant fraction of the material has achieved final disposition already:

- More than 4 MT of low-grade Pu has been disposed as transuranic waste to the Waste Isolation Pilot Plant, as low-level waste to several facilities, or to high-level waste systems.
- Approximately 7 MT of DOE plutonium is contained in highly irradiated used fuel, and is under management by the National Spent Fuel Program.
- Nearly 5 MT of plutonium is retained for programmatic use, including the development of advanced fuel cycles; technology development for the detection of SNM in nonproliferation activities and nuclear forensics; fundamental sub-critical experiments; and smaller, varied research programs.

Of the remaining bulk material, approximately 13 MT of non-pit, surplus plutonium was chosen for disposition through a proposed Plutonium Immobilization Plant (PIP). The PIP project was terminated in 2002 to allow NNSA to devote primary attention to the PDCF/MFFF program; the PDCF and MFFF are required to fulfill the Plutonium Management and Disposition Agreement between the United States and Russia. DOE-EM took over primary responsibility for the disposition of the surplus plutonium under its control.

Of the 13 MT of non-pit surplus plutonium, changes to the MOX program and pre-treatment by DOE-EM have allowed approximately 7.8 MT to become suitable for the MFFF. The remaining 5.2 MT of plutonium is not suitable for transfer to the MOX cycle for chemical, physical, or isotopic reasons. DOE-EM, SRS, and the holding sites continue to evaluate options for final disposition of this material. Once an optimum program is established, DOE plans to select a preferred alternative and publish a Supplemental Environmental Impact Statement for Surplus Plutonium Disposition. Potential candidate technologies are shown in the following figure.⁵

The exact quantity that will be subject to each disposition option remains under review as excess materials are identified at the NNSA sites and the SRS and MFFF operating plans mature. The program may accept additional disposition material after Defense Programs Transformation and Nuclear Posture reviews are completed and programmatic uses for plutonium removed from weapons-program activities are explored.



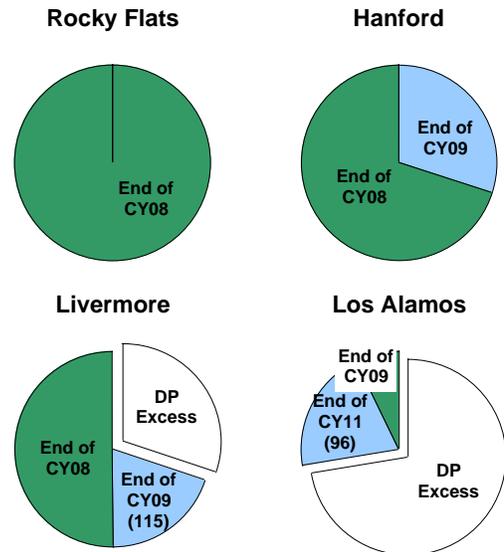
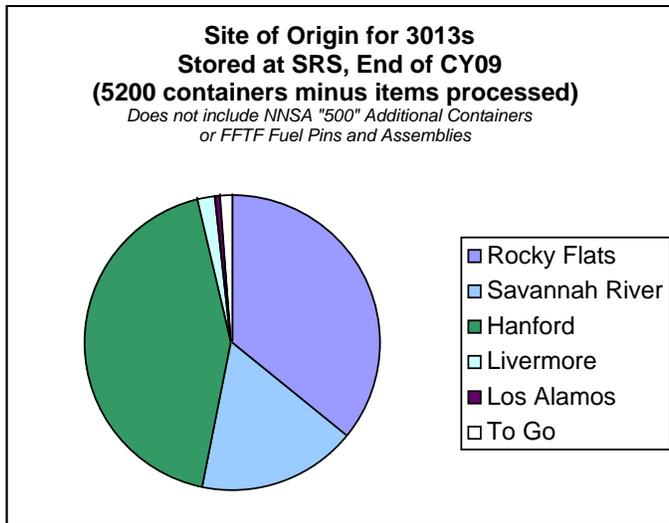
PLUTONIUM CONSOLIDATION PENDING DISPOSITION

In the earlier years of this decade, the surplus materials from Rocky Flats were transferred to SRS for storage pending disposition. Additional surplus material resided at the Hanford Plutonium Finishing Plant and at the NNSA laboratories, LANL and LLNL. This additional surplus includes both items that are compatible with the MFFF and items that require an alternative disposition plan.

In September 2007, DOE announced a plan to consolidate to SRS the remaining surplus, non-pit, unirradiated plutonium from Hanford and 211 containers from LLNL and LANL for which DOE-EM had assumed disposition responsibility.⁶ An additional 500 containers could be received from the NNSA sites on a space-available basis, to provide operational flexibility at the laboratories; alleviate demands on continued storage for excess materials and continuing programs; and to support the de-inventory of SNM from LLNL.

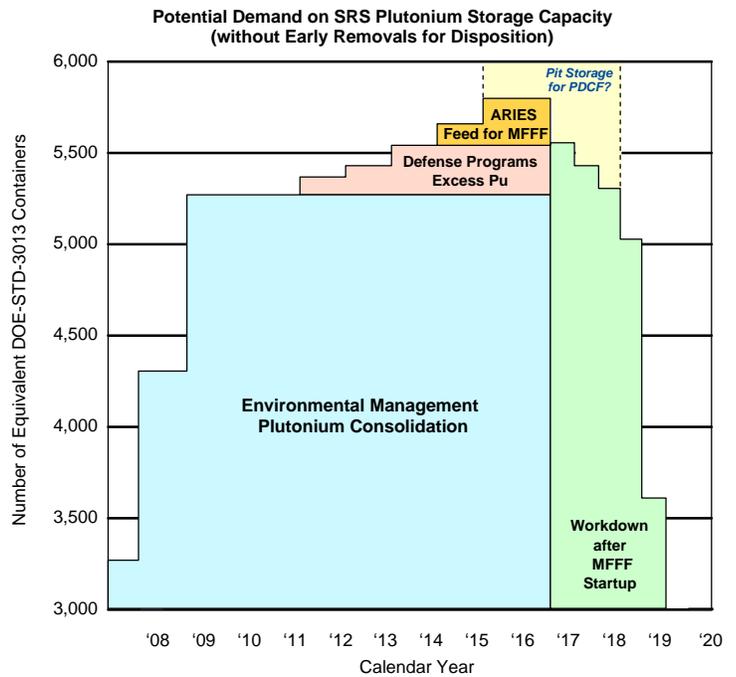
Surplus Non-Pit Plutonium for Consolidation (2008)	
Rocky Flats Metals & Oxides	1,888
Savannah River (incl. RF packaged at SRS)	918
Hanford Metals & Oxides	2,257
Hanford Unirradiated Fuel	n.a.
Los Alamos Rocky Flats Material	96
Livermore Rocky Flats Material	65
Livermore NA-26 Program Material	50
SRS DOE-EM Storage Requirements	5,274
Los Alamos Defense Programs Excess (est.)	250
Livermore Defense Programs Excess (est.)	53
Los Alamos Oxide from Pit Conversion	197
Total Consolidation Storage Target	5,774

The table shows the sites of origin for the DOE-STD-3013 compliant containers that are the subject of consolidation pending disposition, as of mid-2008. Not shown are unirradiated fuel pins and assemblies from the Hanford Fast Flux Test Facility (FFTF) program, which will be received and stored in fuel casks. The containers in the 500 assigned for additional items from LLNL and LANL are based on previous projections for Excess plutonium managed by Defense Programs and oxide that would be produced at Los Alamos from the Advanced Recovery and Integrated Extraction System (ARIES) program, which prototypes operations of the PDCF. The following figures show the progression of storage consolidation projected through the end of 2009; relocation of Hanford and the 115 allocated containers from LLNL will be complete.



Storage capacity at SRS is not limited by building capacity. However, ventilation, services, and configurations changes are required to expand capability further. The current storage configuration was formulated to manage a peak requirement of 5000-5300 DOE-STD-3013 containers and to accommodate HEU materials awaiting disposition as low-enriched uranium in the blenddown program. Previously, up to 2 MT of plutonium-bearing materials were identified for disposal to high-level waste (HLW) using H Area and the Defense Waste Processing Facility (DWPF). Later items, including the Defense Programs (DP) Excess and ARIES oxides from LANL awaiting processing in the MFFF, would fill storage positions that were made available after containers were removed for early disposition.

Modifications that would allow further capacity increases are under evaluation to enable receipt of all NNSA materials in a timely fashion, should removals be delayed further. Requests for storage would peak in 2014-2016 when Los Alamos completes the preparation of 2 MT of Pu oxide, through the ARIES process, for use as early feed to the MFFF when that facility begins operations in 2016. Also under discussion is an opportunity to modify SRS storage for early staging of pit-material feeds to the PDCF, should the option allow early consolidation of surplus items out of Zone 12 at Pantex and avoid storage expansions at Pantex that may result from accelerated weapon retirements and dismantlements.



SUMMARY

The Department of Energy faces a continuing, extended mission of dealing with legacy nuclear materials and facilities. Disposition is likely to be extended beyond 2030 as greater quantities of materials are identified for permanent disposal. In the meantime, DOE continues to consolidate materials and operations in a way that reduces the continued cost of the "Cold War legacy" while maintaining safe, secure, and flexible support for nonproliferation and strategic missions.

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