The Secretary of Energy
Washington, DC 20585

December 28, 1998

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

Enclosed is Revision 1 of the Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 94-1, *Remediation of Nuclear Materials in the Defense Nuclear Facilities Complex*. This Revision describes the current status of and changes to the Department's plans for stabilizing the nuclear materials originally described in the February 1995 Implementation Plan.

I have aligned the Departments's management of the 94-1 Program in accordance with our policy on Integrated Safety Management. Specifically, the Assistant Secretary for Environmental Management will be the Program Secretarial Officer accountable to me for the 94-1 Program. The Deputy Assistant Secretary for Nuclear Materials and Facilities Stabilization will be the Responsible Manager with authority to perform all planning, response and implementation activities. The Responsible Manager will be supported by a management team to ensure timely reporting of progress and identification of potential issues for resolution. I recognize delays at the Hanford K-Basin Spent Fuel Project and Plutonium Finishing Plant were mainly due to contractor management problems, and have committed the Department's resources to support Hanford in stabilizing these materials safely and in a realistic, but as aggressive a schedule as possible. In addition, Department of Energy's (DOE) Assistant Managers for these two projects will be personally accountable for the performance of their project.

In accordance with the President's policy on disposition of highly-enriched uranium, DOE has been working with the Tennessee Valley Authority (TVA) to dilute the highly-enriched uranium solution at the Savannah River Site (SRS) for beneficial use. Due to the recent decline in price for uranium and the continuing need to support our non-proliferation objectives with Russia, TVA and DOE are re-considering some of the assumptions in this joint effort. The issues are expected to be resolved in an Interagency Agreement by April 1999. With the controls SRS has in place for storage of this solution, we believe the risk resulting from this delay in finalizing the Interagency Agreement is acceptable and will be managed.

This revised Implementation Plan represents the most current planning that exists for nuclear material stabilization activities at all involved DOE sites. We recognize that facilities like the Savannah River Site's Actinide Packaging and Storage Facility are on the critical path for stabilizing nuclear materials for potentially more than the Savannah River Site. To that end, we continue to aggressively pursue resolution of technical issues, project sequencing and obtaining resources to complete these vital activities, including construction of the Actinide Packaging and Storage Facility and startup of HB-Line Phase II, as quickly as possible.

We continue to closely track progress on all Recommendation 94-1 commitments and will keep you and your staff apprised of our progress. If you have any questions, please contact me or have your staff contact Mr. David Huizenga on (202) 586-5151.

Yours sincerely,

Bill Richardson

Bill Richardson

Enclosure

Implementation Plan for the Remediation of Nuclear Materials in the Defense Nuclear Facilities Complex (Revision 1)

December 22, 1998

U. S. Department of Energy
Office of Environmental Management

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Implementation Plan for the Remediation of Nuclear Materials in the Defense Nuclear Facilities Complex
(Revision 1)

December 22, 1998

U. S. Department of Energy
Office of Environmental Management

Approved by:

James M. Owendoff Assistant Secretary for Environmental Management	Victor H. Reis Assistant Secretary for Defense Programs
John D. Wagoner Manager, Richland Operations Office	Gregory P. Rudy Manager, Savannah River Operations Office
James C. Hall Manager, Oak Ridge Operations Office	Bruce G. Twining Manager, Albuquerque Operations Office
Jessie M. Roberson Manager, Rocky Flats Field Office	John M. Wilcynski Manager, Idaho Operations Office
James M. Turner Manager, Oakland Operations Office	

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EXECUTIVE SUMMARY

The Defense Nuclear Facilities Safety Board ("DNFSB" or "Board") issued Recommendation 94-1 on May 26, 1994. In Recommendation 94-1 the Board noted its concern that the halt in production of materials to be used in nuclear weapons froze the manufacturing pipeline in a state that, for safety reasons, should not be allowed to persist unremediated. Specifically, the Board expressed concern about certain liquids and solids containing fissile materials and other radioactive materials in spent fuel storage pools, reactor basins, reprocessing canyons, and various other facilities once used for processing and weapons manufacture. The Department of Energy ("DOE" or "the Department") accepted the Board's Recommendation on August 31, 1994, and submitted its implementation plan on February 28, 1995. In December 1997, the Board called upon the Department to prepare a comprehensive revision to the 94-1 Implementation Plan. The Department acknowledges and continues to share the Board's concerns regarding nuclear materials stabilization and has developed this revision to the original integrated program plan to continue to address these urgent problems.

The measures outlined in this plan to stabilize nuclear materials constitute an important part of an integrated management process to address these urgent issues. In accordance with the first principle in Integrated Safety Management, DOE has realigned its management organization for the 94-1 effort. The Assistant Secretary for Environmental Management (EM-1) is the lead Program Secretarial Official (PSO) for the Department since most of the nuclear materials stabilization activities are under his purview. The Responsible Manager (RM) is the Deputy Assistant Secretary for Nuclear Material and Facility Stabilization, who has authority to perform all associated planning, response, and implementation activities. A member of the Nuclear Materials Stewardship Program Office (EM-66) is assigned as the Recommendation 94-1 Implementation Plan Manager (IPM). The Responsible Manager and the Implementation Plan Manager will work with appropriate managers from the Offices of Defense Programs (DP) and Environmental Management (EM) to ensure that stabilization activities at DP and EM sites are completed in a safe and timely manner.

The Responsible Manager is supported by a 94-1 Management Team, consisting of representatives from each of the Program Offices at Headquarters that have 94-1 related stabilization activities at Field locations under their cognizance. The Offices of Materials Disposition (MD); Environment, Safety and Health (EH); Departmental Representative to the Board; and EM's Office of Science and Technology will also be represented on the 94-1 Management Team. This Management Team will integrate activities across the sites and the material categories, managing interfaces among utilization, stabilization and disposition programs. The team will also work to make the most efficient use of the complex's facilities, examine methods and alternatives for improving practices and schedules as this effort continues and evaluate status of the Department's progress in meeting the Secretarial commitments given in the Implementation Plan to the Board.

DOE has already completed all but one of the 58 actions called for in the February 1995 Implementation Plan to mitigate the urgent risks highlighted by the Board in Recommendation 94-1; sufficient compensatory measures together with actions to improve aggressiveness of the stabilization strategy are in place to ensure plutonium liquids stored in the Hanford Plutonium Finishing Plant will not pose undue risk to our workers.

DOE has made progress in stabilizing nuclear materials for long term storage, ready for disposition. For example; 87% of all Pu solutions, 47% of residues and mixed oxides, 39% of special isotopes, 18% of uranium solids and 7% of spent nuclear fuel have been stabilized. The remaining material stabilization actions that must be completed are summarized below. A complete description of these activities for each site is found in the implementation plan body, and a crosswalk of the remaining commitments and their revised due dates from the original plan is located in Appendix D. These modifications are necessary due to implementation of several major DOE programs, technical improvements, operational problems and resource limitations. Integrated safety management systems are either in place or being implemented at these sites to ensure continued safe storage and stabilization of nuclear materials.

Remaining Actions Required for Closure of Recommendation 94-1

For the purposes of this Implementation Plan, the Department defines closure of the actions related to Recommendation 94-1 as follows:

- All 94-1 plutonium metal and oxide is packaged according to the long-term storage standard.
- All 94-1 special isotope materials are in a form suitable for long-term storage.
- All 94-1 spent nuclear fuel is stabilized by dissolution or transferred to appropriate storage.
- All 94-1 uranium is in a form suitable for long-term storage.
- All 94-1 low assay materials are packaged in accordance with the Interim Safe Storage Criteria.

Hanford

- All plutonium solutions will be stabilized by December 2001 (35-month delay)
- All plutonium metal will be packaged to conform to the long term storage standard by May 2002 (no change)
- All plutonium oxide will be packaged to conform to the long term storage standard by December 2004 (31-month delay)
- All residues <50% plutonium will be stabilized by June 2003 (13-month delay)
- All spent nuclear fuel and sludge will be removed from the K-Basins by August 2005 (3½-year delay).

Savannah River

- All plutonium solutions will be stabilized byJune 2002 (27-month delay)
- All pre-existing metal and oxide >50% plutonium will be packaged to conform to DOE-STD-3013-96 by May 2002 (no change)
- All residues <50% plutonium will be stabilized by September 2004 (24-month delay)
- All americium/curium solutions will be stabilized by September 2002 (34-month delay)
- All neptunium solutions will be stabilized by December 2005 (27-month delay)
- All Mark 16 and Mark 22 spent nuclear fuel will be dissolved by December 2001 (12-month delay)
- All uranium solutions will be stabilized by December 2003 (6-year delay for pre-existing solutions)
- All RockyFlats residues and scrub alloy will be stabilized by May 2002 (4-year delay for RFETS SS&C)

Rocky Flats

- All piping systems will be drained and the plutonium solutions stabilized by March 2002 (33-month delay)
- All metal and oxide >50% plutonium will be packaged to conform to DOE-STD-3013-96 by May 2002 (no change)
- All high risk residues will be stabilized by July 1999 (13-month delay for high risk salts)
- All remaining residues will be packaged for off-site shipment by May 2002 (no change)

Oak Ridge

- All plutonium will be packaged and shipped off-site by May 2002 (no change)
- All uranium-233 will be removed from the Molten Salt Reactor Experiment by May 2002 (no change)

Los Alamos National Laboratory

- All legacy[1] metal and oxide will be inspected and repackaged by September 2003 (16-month delay)
- All legacy residues will be stabilized and the plutonium recovered as oxide by September 2005 (40-month delay)

Lawrence Livermore National Laboratory

- Complete plutonium metal and oxide repackaging by May 2002 (no change)
- Stabilize and package LLNL's ash residues by May 2000 (13-month delay)
- Stabilize and package all other LLNL residues by February 2001 (10-month delay)

Idaho National Engineering and Environmental Laboratory

- Complete Fuel Removal from CPP-603 Underwater Storage Facility by December 2000 (no change)

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[1] Legacy materials are those with a creation date before May 1994.

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1.0 BACKGROUND

The Defense Nuclear Facilities Safety Board (DNFSB or Board) issued Recommendation 94-1 on May 26, 1994. The Department of Energy (DOE or the Department) accepted the Board's Recommendation on August 31, 1994, and submitted its implementation plan on February 28, 1995. The Board noted, in Recommendation 94-1, that it was concerned that the halt in production of materials to be used in nuclear weapons froze the manufacturing pipeline in a state that, for safety reasons, should not be allowed to persist unremediated. Specifically, the Board expressed concern about certain liquids and solids containing fissile materials and other radioactive materials in spent fuel storage pools, reactor basins, reprocessing canyons, and various other facilities once used for processing and weapons manufacture. The Department acknowledges and continues to share the Board's concerns and has developed this revision to the original integrated program plan to continue to address these urgent problems.

At about the same time, the Department of Energy (DOE) initiated activities to investigate the conditions of nuclear materials within the Department. Working groups were established to visit sites and assess the status of specific categories of nuclear material. The following reports provided a detailed description of the amount, location, condition and vulnerabilities associated with much of this material:

- *Spent Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and Other Reactor Irradiated Nuclear Materials and Their Environmental, Safety, and Health Vulnerabilities (November 1993)*

- *Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage (November 1994)*

- *Highly Enriched Uranium Working Group Report on Vulnerabilities (December 1996)*

The *Spent Fuel Working Group Report* identified significant vulnerabilities causing the Department to study alternative programmatic solutions. In addition, and as a result of a court order (Civil No. 91-0035-S-HLR, 6/28/93), the Department prepared the Programmatic Spent Nuclear Fuel Environmental Impact Statement. The final statement was issued in April 1995, with a Record of Decision on June 1, 1995.

The Departmental assessments identified above and the independent observations and concerns expressed by the Board made the following issues clear:

- There is an urgent requirement to address the growing technical problems associated with handling, stabilizing and storing excess nuclear material. These problems are especially noteworthy because the recent downsizing of the weapons complex has resulted in the loss, without replacement, of many of the skilled workers needed to correct the problems. This decreasing experience base, coupled with the increasing age of the facilities, makes the control of nuclear material and the prevention of inadvertent criticality events, uncontrolled exposure, and personnel contamination a continuing concern.

- The efforts to stabilize nuclear materials was heretofore limited to those undertaken by individual field organizations and constrained by each site's resources. Consequently, the stabilization of nuclear material was pursued with different priorities, assets and treatment techniques. Several mutually exclusive and, in some cases, duplicative programs evolved. Without a Departmental perspective, some options for solving the problem were not adequately assessed (e.g., transporting all material of a certain type to one site for processing, versus processing material at multiple sites).

The Department initially broadened the scope of the response to Recommendation 94-1 to include additional bulk liquids and solids containing fissile materials and other radioactive substances in spent fuel storage pools, reactor basins, reprocessing canyons, processing lines and various facilities which require conversion to forms, or establishing conditions, suitable for safe interim storage. The scope was broadened to ensure that similar materials under similar conditions receive the same degree of management attention as those noted by the Board in its Recommendation.

Much progress has been made to address the concerns specified in the Department's vulnerability reports and the Board's Recommendation 94-1. This Implementation Plan revision will provide an update on the completed actions from the original 94-1 plan. This revision will also describe the path forward for correcting the remaining material vulnerabilities which were addressed in the original 94-1 Implementation Plan.

2.0 UNDERLYING CAUSES

Throughout the Cold War the Department of Energy was responsible for the development, manufacturing, maintenance and testing of the United States' arsenal of nuclear weapons. At the conclusion of the Cold War a majority of the Department's facilities that performed the various elements of work necessary to produce these nuclear weapons had been shutdown for various safety reasons with the expectation that they would be required to resume production within a relatively short time. Subsequently, world events have been such that the shutdown facilities have not resumed production and, as a consequence, the Department has shifted its emphasis from nuclear material production to environmental management to mitigate the risks caused by chemical and nuclear instability of the materials remaining in the facilities.

When nuclear weapons were being produced and the stockpile was growing, the vast majority of fissile material scrap and materials from retired weapons was recycled. It was less costly to recover fissile materials from high assay scrap and retired weapons than to produce new material. As a result, very little scrap containing fissile material was considered surplus. Consequently, these materials were designated, handled, and packaged for short-term storage; therefore, when the weapon production lines were halted in the late 1980s, many materials were left in conditions unsuitable for long-term storage.

In early 1994, the Defense Nuclear Facilities Safety Board (DNFSB, Board) issued its Recommendation 94-1, which expressed the Board's dissatisfaction with the slow pace of actions being taken to correct the conditions brought to light during the plutonium and spent fuel assessments. In response, in February 1995 the Department issued its Recommendation 94-1 Implementation Plan. The Plan represented an integrated Department-wide program to provide timely mitigation of those vulnerabilities identified in the vulnerability assessments which presented the highest risks to worker, facility, and environment. For example:

- The by-products left from the processing of plutonium into weapons-grade components left a large legacy of deteriorating plutonium residues, metal and oxides in both solution and solid form at several facilities such as Hanford, Rocky Flats, and Savannah River. These materials require timely stabilization and repackaging to prevent further deterioration and increase in the already unacceptable safety risks they present.

- The production and processing of plutonium and other nuclear materials at Hanford, the Idaho Engineering and Environmental National Laboratory, and Savannah River left a large legacy of spent nuclear fuel in storage pools. Both the fuel and the sludge emanating from the deteriorating fuel have become a significant environmental threat that mandates timely action to prevent further increase in the associated risks.

- To provide suitable fuel for reactors used to produce the plutonium that was turned into weapons-grade metal components required processing natural uranium to produce enriched uranium. The by-products of this process continue to contaminate major facilities at both Oak Ridge and Savannah River. The risks associated with the highest risk solid deposits of uranium isotopes in an uranium enrichment facility at Oak Ridge have been mitigated, however, cleanup of a shutdown experimental production reactor at that site continues to require attention. Savannah River has a large quantity of a uranium solution stored in its H-Canyon that is both a chemical and a radiological hazard that requires timely mitigation.

- The process of producing and purifying plutonium at Savannah River left a particularly hazardous inventory of special isotopes in both solution and solid forms that present significant safety risks.

A number of modifications to the 94-1 Implementation Plan have become necessary since it was originally promulgated. These modifications are due to approval of major Departmental initiatives such as:

- *Accelerating Cleanup: Paths to Closure*, which describes the Department's plans to accelerate closure of facilities and sites under the auspices of the Office of Environmental Management
- *The Rocky Flats Closure Project Management Plan*, which outlines specific actions the Department is taking to accelerate the cleanup and closure of Rocky Flats
- The Record of Decision for the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* regarding storage of surplus weapons-usable plutonium and highly-enriched uranium (HEU) pending disposition, and the strategy for disposition of plutonium
- The Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement within the Office of Defense Programs which assigned new missions to some DP facilities

Modifications have also been necessitated by technical improvements, previously unforeseen problems, and schedule changes that have been encountered as stabilization and repackaging progressed at various sites. In December 1997 the Board called on the Department to prepare a comprehensive revision to the 94-1 Implementation Plan to capture all known and planned changes from the original Plan. This document is that revision.

3.0 BASELINE ASSUMPTIONS

Key Assumptions

In order to achieve the commitments outlined in this implementation plan, there are several key assumptions identified for each of the material categories presented in Section 5.2. These key assumptions include:

- Environmental and other studies will be used to develop alternatives; selection of an alternative will be made through Records of Decision. For most of the materials described in Section 5.2, the decisions made pursuant to the NEPA process are assumed to be consistent with the options described such that the milestone dates can be achieved. The NEPA process is a key element of DOE's planning process and the principal means of achieving stakeholder involvement.

- Adequate resources to address the identified issues will be made available in the time frame necessary to meet the milestones.

- A new standard will be developed to capture the spectrum of 94-1 materials requiring safe long-term storage and meet the performance aspects of DOE-STD-3013-96. The reasons for this revision are to extend the scope of covered materials to include items down to 30 wt% plutonium and uranium; to extend the storage temperature to 250°C; and to develop alternate technologies for measuring residual moisture.

- The 94-1 Research and Development Program (described in Appendix G) will provide the needed technologies to support the commitments and schedules in this plan.

- Facilities will be restarted and operated within the context of each site's Integrated Safety Management System.

- Transportation issues (i.e., containers, logistics, environmental and stakeholder concerns) will be identified early and resolved.

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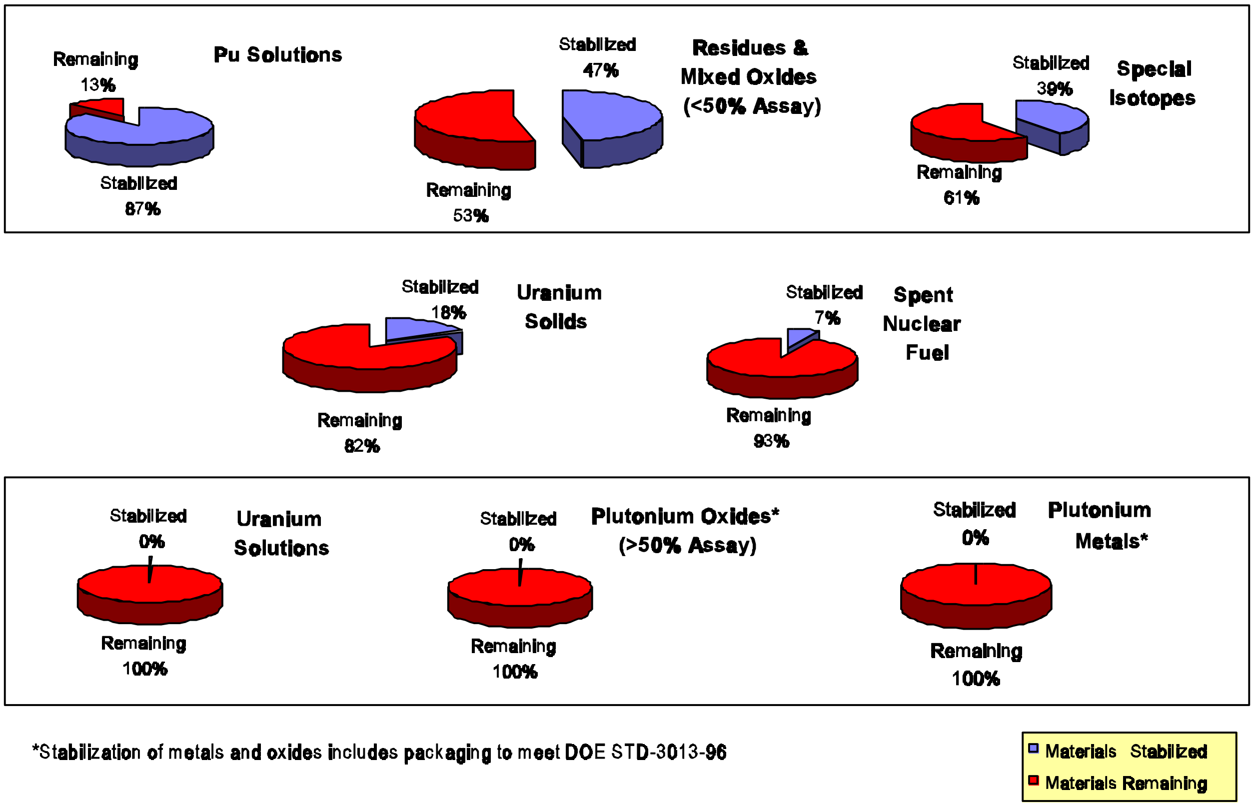
4.0 SUMMARY OF COMPLETED ACTIONS

Figure 4.1 shows the progress that has been made in stabilizing the inventories of the various categories of nuclear materials included in the 94-1 Implementation Plan. In addition, by completing numerous risk reduction actions that were called for in the original 94-1 Implementation Plan, sites have significantly reduced the risk posed by those materials awaiting stabilization. A portion of those completed actions are described below, and a listing of all 94-1 activities completed to date is included in Appendix F.

Figure 4.1: Completed Actions: Material Stabilization Progress



*Stabilization of metals and oxides includes packaging to meet DOE STD-3013-96

Hanford

- High risk ash stabilized
- All bottles of Plutonium solution checked to ensure proper venting
- Cofferdams installed at K-Basins

Los Alamos National Laboratory

- Performed 100 percent visual inspection of vault inventory
- Stabilized all high-risk vault items

Lawrence Livermore National Laboratory

- Performed 100 percent verification of no plutonium metal in contact with plastic

Oak Ridge

- Uranium deposits with criticality potential removed at K-25 and K-29
- Interim actions taken to preclude criticality at MSRE
- Potentially explosive fluorinated charcoal denatured
- Over 50 percent of uranium inventory removed as gaseous Uranium Hexafluoride

Mound

- All plutonium metal in contact with plastic has been repackaged

Rocky Flats

- Vented all 2,662 residue drums
- Drained all tanks of high-level plutonium solutions (over 16 tanks) and stabilized solutions
- All plutonium metal in contact with plastic has been repackaged
- Started processing all major residue categories
- All highly-enriched uranium solutions (2,700 L) shipped off-site and stabilized

Savannah River

- Stabilized 303,000 liters of plutonium-239 solutions at Savannah River
- Stabilized 13,300 liters of plutonium-242 solution at Savannah River
- Stabilized all Mark-31 targets at Savannah River
- All plutonium metal in contact with plastic has been repackaged
- 56 percent of all plutonium metal onsite has been packaged in a DOE-STD-3013-96 inner container

5.0 SAFETY ISSUE RESOLUTION

5.1 Department's Analysis of the Safety Issues Described within the Board's Recommendation

The halt in the production of nuclear weapons, and materials to be used in nuclear weapons, froze the manufacturing pipeline in a configuration which was not intended for long term storage. If left unremediated, these materials could pose unacceptable health and safety risks to workers and the public. The Board, concerned with the slow pace of remediation, expressed its belief that the existing configuration of some materials in the manufacturing pipeline could pose imminent hazards unless remediated. Therefore, in its 94-1 Recommendation, the Board made nine specific sub-recommendations to the Secretary of Energy.

Review of the discussion contained in Recommendation 94-1 indicates that there were three safety issues which led to the nine sub-recommendations.

1. *Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.*

2. *Within a reasonable amount of time, remaining materials should be stabilized and safely stored before aging causes them to become an imminent health and safety hazard to workers and the public.*

3. *Research should be performed to fill any gaps in the information base needed to allow DOE to choose between alternate processes used to convert fissile materials into a form suitable for long-term storage and disposal.*

The Department has already taken action to address materials which could pose an imminent safety hazard (See Section 4.0). Where imminent hazard materials were not stabilized, site-specific actions for safe storage through prevention and mitigation measures are addressed later in this implementation plan. This revised implementation plan outlines the course of action being taken to stabilize and safely store materials "frozen" within the weapons manufacturing pipeline. The approach to resolving the safety issues includes:

- A technical basis for material stabilization. The technical basis categorizes the different types of nuclear materials, identifies the location and quantity of material within each category, defines the general hazards posed by each category of material, and outlines the techniques available for material stabilization (Section 5.2).

- A qualitative risk evaluation to ensure that any increased risk caused by delays in meeting the original implementation plan commitments is being adequately managed (Section 5.3).

- Remediation actions to address the safety issues applicable to each affected DOE site (Section 5.4).

5.2 Technical Basis

5.2.1 Plutonium Stabilization and Storage Standard

The Special Nuclear Materials (SNM) declared “excess” will be stabilized and packaged per DOE-STD-3013-96 for 50-year interim storage by the Materials Disposition (MD) program. The DOE-STD-3013-96 standard covers a range of 50–100 wt% plutonium; however, MD’s acceptance criteria cover the range 30–100 wt% plutonium and uranium. In addition, other SNM categories exhibit inconsistencies with DOE-STD-3013-96 (e.g., some high-decay heat metals exceed the 100°C storage limit).

In an effort to broaden the range and overcome some known limitations of DOE-STD-3013-96, a concerted effort was applied to better characterize the various categories of SNM and develop a strategy to meet the MD 50-year interim storage criteria. Ongoing research and development to revise DOE-STD-3013 is expected to overcome the known limitations and fully meet MD interim storage requirements for the range of SNM from 30 wt%–100 wt% plutonium and uranium. The revised standard is expected to be issued during FY 1999.

5.2.2 Plutonium Solutions

Approximately 412,000 liters of Pu-239 solutions existed throughout the DOE complex, primarily at Rocky Flats, Savannah River, and Hanford, at the time the Plutonium Vulnerability Assessment was completed in 1994. These plutonium nitrate and chloride solutions were in the process of being converted to a purified plutonium metal or oxide, or in facility process system hold-up, when the facilities were shutdown. Currently, approximately 53,000 liters require stabilization.

Table 5.2.2 compares the plutonium solutions inventories at the three major sites. The tabulated information includes quantities existing at the time the original Recommendation 94-1 Implementation Plan was promulgated and changes in the inventories that have occurred since then. Some changes in total quantities to be stabilized have occurred, primarily due to completion of stabilization requirements and improved inventory accuracy.

Continued storage in their existing configuration pose exposure hazards due to leakage, criticality hazards due to concentration and precipitation of fissile material, and explosion hazards due to the generation of gasses in tanks and processing lines. Plutonium solutions was considered to have the potential to pose an imminent hazard within two to three years.

Solidification is used to stabilize plutonium solutions. Once solidified, the plutonium metal/oxide would be safely stored until final material disposition is determined. Since intersite transport of plutonium solutions is prohibited, integration of stabilization capabilities between the sites is not an option under consideration. Stabilization at each site ranges from the use of existing facilities, such as Savannah River’s F-Canyon, to the development of new systems such as calcination at Hanford’s Plutonium Finishing Plant.

Table 5.2.2: Plutonium (Pu-239) Solutions Inventory Summary

Site	Plutonium Content (Kg)	Original Quantity (L)	Original Location	Adjusted Inventory (L)	Adjusted Plutonium Content	Remaining to be Stabilized	Plutonium Stabilized (Kg)	Remaining Solutions Location
Rocky Flats	143	30,000	Bldgs 371, 559, 771, 776/777, 779	30,000	143 Kg	15,527+ L ‡ (as of 6/01/98)	100	Bldgs 371, 559, 771
Savannah River	Classified	320,000	F-Canyon	--*	--	0	Classified	--
Savannah River	Classified	34,000	H-Canyon	34,000	Classified	34,000 L	0	H-Canyon
Hanford	358	4,800	Plutonium Finishing Plant	4,690**	341	4,300 L	15	PFP
Hanford	9	22,700	PUREX	--	--	0	None***	Tank Farm

* Stabilization of F-Canyon solutions by conversion to metal was completed in April 1996.

** Quantity adjusted from EIS bounding case to reflect correct quantity.

*** Neutralization and transfer of PUREX solutions to the tank farms was completed in April 1995.

‡ The actual plutonium solutions drained from piping systems are expected to be an order of magnitude less than estimated.

5.2.3 Plutonium Metals and Oxides (> 50% assay)

The DOE currently manages large quantities of plutonium metal and oxide which are not adequately packaged for long-term storage. In general, the metal and oxide exists in several grades and forms, and is packaged in a multitude of configurations, most of which were prepared a number of years ago and are not suitable for long-term storage.

Tables 5.2.3-1 and 5.2.3-2 respectively compare the metal and oxide (>50%) inventories at the affected sites. The tabulated information includes the quantities described the original Recommendation 94-1 Implementation Plan and changes in the inventories that have occurred since then.

Continued storage in their existing configurations pose pressurization and explosion hazards where these materials were packaged in contact with plastic. Plastic packaging materials used in the storage of these materials breakdown through radiolysis to generate hydrogen and oxygen. In addition, pyrophoricity hazard exists when hydriding of plutonium metal occurs, and exposure hazard through personnel contamination through container degradation. Metals and oxides stored in contact with plastic were considered to have the potential to pose an imminent safety hazard. Other material configurations were considered to pose a lower safety hazard potential.

DOE's commitment is to place all plutonium metal and oxide which is excess to programmatic needs into a form which is suitable for storage until disposition of the material can be accomplished. For metal, stabilization is accomplished by brushing to remove any oxide which has formed on the item's surface then packaging in a welded container in an inert atmosphere using a "bagless transfer" technology[2] which does not require the use of plastic bags or gaskets. Oxide is packaged similarly, however before packaging it is heated to a high temperature to drive off any moisture or organics that may have been absorbed in the material. Additional metal or oxide materials which are generated at processing sites from the stabilization of other material forms will be packaged to the same standard.

An exception to the above description is scrub alloy, a plutonium-rich alloy material which is the byproduct of a process used to purify plutonium. Scrub alloy contains high quantities of americium which poses a radiation exposure hazard. Current plans are for scrub alloy to undergo a separation process to remove constituents from the alloy which would otherwise make it unacceptable to the Materials Disposition program. The current plans would consolidate this material at Savannah River for stabilization in the canyon facilities.

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[2] At LANL the AIRES System will utilize electrolytic decontamination technology to meet the 3013 Standard requirements.

Table 5.2.3-1: Plutonium Metals

Site	Original SNM Inventory (kg)	Original Number of Items	Original Locations	Adjusted Number of Items	Remaining to be Stabilized	Remaining Items' Location(s)
Rocky Flats	6,600	3,403	371, 559, 707, 771, 776/ 777, 779,991	3,403	3,403	371, 707, 776/ 777 (Note 1)
Hanford	700	350	PFP, PNL*	352 (Note 2)	339	PFP
Los Alamos	1133	2000	TA-55, CMR, TA-18	0 (Note 3)	n/a	n/a
Savannah River	490	450	FB-Line, 235F, SRTC	350	350	FB-Line, 235F, SRTC
Argonne-West	**	**	ZPPR, FMF, 752	**	**	ZPPR, FMF, 752
Argonne-East	0.45	210	205, 212, 315	210	210	205, 212, 315
Lawrence Livermore	20	250	B 332	91*** (Note 4)	91	B 332
Mound	0.855	20	T, SW\R	20	0	n/a
Oak Ridge	0.3013	30	3027, 3038, 5505	30	30	3027, 3038, 5505
Sandia	6.7	5	NMSF	5	5	NMSF

* PNL had 254 packages of metal/oxide/residues in addition to the 350 shown for PFP.

** The major holdings are about 2,600 containers of metals/oxides.

*** Material in excess of programmatic needs.

Notes:
1. Material storage consolidated to listed locations.
2. 350 in original Implementation Plan was a rounded number.
3. See Section 5.4.5.
4. Programmatic activity has generated new material and/or used some material which was in the original program, e.g., the Immobilization Program used some material for testing.

Table 5.2.3-2: Plutonium Oxides (> 50 % Assay)

Site	Original SNM Inventory (kg)	Original Number of Items	Original Locations	Adjusted Number of Items	Remaining to be Stabilized	Remaining Items' Location(s)
Rocky Flats	3,200	3,296	371, 559, 707, 771, 776/ 777, 779,991	3,296	3,296	371, 707, 776/ 777[1]
Hanford	1,500	2,500	PFP, PUREX, PNL*	2,611[2]	2,611	PFP
Los Alamos	721	2,000	TA-55, CMR, TA-18	0[3]	0	n/a
Savannah River	650	550	FB-Line, HB-Line, 235F, SRTC	800[4]	800	FB-Line, 235F, SRTC
Argonne-West	**	**	ZPPR, FMF, 752	**	**	ZPPR, FMF, 752
Argonne-East	0.48	695	200, 306, 315	695	695	205, 212, 315
Lawrence Livermore	102	154	B 332	92[5]	92	B 332
Mound	28.132	107	T, SW\R	107	0	n/a
Oak Ridge	1.706	83	3027, 3038, 5505, 7920, 7930, 9204-3	83	83	3027, 3038, 5505
Lawrence Berkeley	0.014	354	70, 70A, 70-147A	354	354	70, 70A, 70-147A
Sandia	1.4	10	HCF, ACRR, NMSF	10	10	NMSF

* PNL had 254 packages of metal/oxide/residues.

** The major holdings are about 2,600 containers of metals/oxides.

*** Material in excess of programmatic needs.

Notes:
1. Material storage consolidated to listed locations.
2. Better split between oxides >50% and residues.
3. See Section 5.4.5.
4. More accurate inventory and characterization of material.
5. Programmatic activity has generated new material and/or used some material which was in the original program, e.g., the Immobilization Program used some material for testing.

5.2.4 Plutonium Residues and Mixed Oxides (< 50% assay)

Solid process residues are bulk materials contaminated with significant quantities of plutonium. The residues which now remain represented feedstock and materials-in-process to nuclear weapon fabrication and nuclear material production until fabrication ceased in 1989. The residues include materials such as impure oxides and metals, halide salts, combustibles, ash, dissolver heels, sludge, contaminated glass and metal, and other items. Table 5.2.4 describes the residue inventories at the various DOE sites.

Since 1989, these residues have remained in packages in processing areas, vaults, and process lines awaiting disposition. They are not currently in a configuration suitable for long-term storage. The form of some materials, such as ash, poses a dispersibility hazard. Other materials, such as salts, may contain small particles of pyrophoric materials which create a worker safety hazard. The November 1994 Plutonium Vulnerability Assessment categorized facilities as “high vulnerability” in some cases due to a portion of the residue inventory which posed an imminent safety hazard. This part of the inventory included such items as residues in unvented drums at Rocky Flats, and reactive materials in packaging inappropriate for long-term storage. Other types of residues were considered to pose a lower safety hazard potential.

Processing, treatment, stabilization, and/or repackaging of residues has already commenced at several sites. Capabilities to deal with the various types of residues exist at multiple facilities. Trade studies have been used extensively to examine and compare options for stabilization of various residue categories. Efforts are being made to integrate the stabilization plans throughout the complex to take advantage of the unique capabilities some sites offer.

Table 5.2.4: Summary of Plutonium Residue and Mixed Oxides (<50% Assay)

Site	Original SNM Inventory (Kg)	Original Number of Items	Original Locations	Adjusted Number of Items	Number of Items Remaining to be Stabilized	Remaining Items' Locations
Rocky Flats	3,000	20,532	371, 559, 707, 771, 776/777, 779,991	20,532	7,840	371, 707, 776, 777
Hanford	1,500	5,000	PFP, PUREX, PNL	4,034[1]	3,977	PFP
Los Alamos	1,400	6,300	TA-55, CMR	7,327[2]	4,757	TA-55, CMR
Savannah River	Classified	1,306	235-F, FB-Line, SRTC	1,000[3]	828	235-F, FB-Line, SRTC
Lawrence Livermore	35	182	B332	202[4]	202	B332
Mound	3	39	T Building	39	0	N/A
Argonne-East	<1	12		12	12	
Oak Ridge	0.1	12	3027, 7930	12	12	3027, 7930
Lawrence Berkeley	<1	250		250	250	

Notes:
1. Adjusted split between residues <50% and oxides >50%.
2. Additional items were identified as needing stabilization.
3. More accurate inventory and characterization of material.
4. Programmatic activity has generated new material and/or used some material which was in the original program, e.g., the Immobilization Program used some material for testing.

5.2.5 Special Isotopes

The DOE manages inventories of a wide range of special transuranic isotopes, primarily derived as byproducts from previous defense reactor production and the chemical separation of large process streams of reactor targets. Special isotope inventories covered by the original 94-1 Implementation Plan are shown in Table 5.2.5 together with their current status. DOE production processes created quantities of plutonium-242, neptunium, americium, and curium solutions which were retained as feedstocks for the future production of heavy isotopes. As in the case of the plutonium solutions described earlier, continued storage of these materials in solution form poses an unacceptable risk, primarily due to potential for leakage and release to the environment. Stabilization of these materials to a solid form suitable for long-term storage is has been completed in the case of plutonium-242 and is planned for neptunium and americium/curium solutions. Stabilization can be accomplished via conversion to a solid oxide form or via vitrification in a glass matrix. New adsorption technologies developed in Russia are also being evaluated regarding their potential for stabilization applications. The Nuclear Materials Integration project is utilizing a systems approach to examine the life-cycle management of these materials.

Table 5.2.5: Special Isotopes Holdings

Inventory	Location	Original Quantity	Current Status
Americium-curium solution	Savannah River F-Canyon	14,400 L	Awaiting stabilization.
Pu-242 solution	Savannah River H-Canyon	13,300 L	Stabilization completed.
Np-237 solution	Savannah River H-Canyon	6,000 L	Awaiting stabilization.
Pu-238 solids with adverse packaging	Savannah River Building 235-F	14 containers	Stabilization completed.
Pu-238 materials in active programs	Los Alamos, Mound	A wide variety of container types	Management of excess materials being examined by Nuclear Materials Integration Program.
Wide inventory of in-use and small-mass items of other isotopes	Large number of DOE, university, medical, and industrial sites	A wide variety of container types	Management of excess materials being examined by Nuclear Materials Integration Program.

5.2.6 Highly-enriched Uranium Stabilization Requirements

The Department currently manages significant quantities of enriched uranium in a number of configurations, including materials left in a production cycle when the production facilities were shut down. Much of the highly-enriched uranium (HEU) inventory included in the original implementation plan has been stabilized, as shown in Table 5.2.6 and described in section 4.1. For the remaining HEU to be stabilized, Savannah River plans to blend the HEU solutions at that site into a low enriched uranium configuration suitable for use as commercial reactor fuel. Details of this project can be found in the *Off-Specification Fuel Project Plan*. HEU solids remaining in the Oak Ridge Molten Salt Reactor Experiment will be removed and turned over to be managed under the uranium-233 Safe Storage Program Execution Plan .

Table 5.2.6: Highly-enriched Uranium Inventory Summary

Site	Type of Material	Original Quantity	Original Location	Quantity Stabilized as of 6/30/98	Remaining Materials Location
Rocky Flats	HEU Solutions	2,700 L containing 569 kg of U-235	Bldg 886	2,700 L	All solutions shipped to commercial processor, converted to oxide, and now stored at Y-12
Savannah River	HEU Solution	230,000 L	Bldg 221-H	0	Bldg 221-H
Oak Ridge	HEU Solids	Classified	K-25 and K-29*	All deposits identified for stabilization are completed	Packaged for interim storage in Y-12 awaiting final disposition
Oak Ridge	U-233 Solids and UF_6 Gas	37.6 kg uranium (84% U-233, 5% U-235)	MSRE	17.5 kg of uranium in the form of U-233 UF_6 adsorbed on NaF traps and removed**	MSRE

* Additional large deposits of low enriched uranium in Building K-29 were selected for removal and were added to the scope of the ETTP Deposit Removal Project.

** Stabilization of MSRE fuel to meet the intent of 94-1 is accomplished upon conversion of this material to an oxide. Conversion is scheduled to begin in August 2000.

5.2.7 Spent Nuclear Fuel

Spent Nuclear Fuel (SNF) is nuclear fuel or targets containing uranium, plutonium, or thorium withdrawn from a nuclear reactor or other neutron irradiation facility following irradiation, the constituent elements of which have not been separated by chemical reprocessing. These materials include essentially intact fuel and disassembled or damaged units and pieces; irradiated reactor fuel, production targets, slugs, and blankets presently in storage or that will be accepted for storage at DOE facilities; and debris, sludge, small pieces of fuel, and cut up irradiated fuel assemblies awaiting evaluation of their waste classification. In their Recommendation, the Board highlighted concerns involving SNF located in the K-East Basin at the Hanford Site, the CPP-603 Basin at the Idaho National Engineering and Environmental Laboratory, and the processing canyons and reactor basins at the Savannah River Site. This material, described in Table 5.2.7, represents a subset of the total inventory of spent nuclear fuel managed under the DOE SNF Program. At Hanford, the only material covered by 94-1 is SNF and sludge in the K-East and K-West Basins. At Idaho, SNF in the CPP-603 Basin comprised the 94-1 inventory. At Savannah River Site, Mark-31 targets (now stabilized) and Mark-16 and -22 SNF made up the 94-1 inventory.

Table 5.2.7: 94-1 Spent Nuclear Fuel Inventory Summary

Site	Original MTHM	Original Volume (m_3)	MTHM Requiring Stabilization (as of 6/30/98)	Volume Requiring Stabilization (m_3) (as of 6/30/98)
Hanford	2,132	256	2,132	256
Idaho	2.9*	64.4*	1.48	4.4
Savannah River	154**	83.5**	7	57.5

* The February 1995 94-1 Implementation Plan showed the values of 261 MT and 702 m^3 for the total SNF inventory at Idaho. The above values represent the 94-1 portion of that inventory.

** The February 1995 94-1 Implementation Plan showed the values of 206 MT and 164 m^3 for the total SNF inventory at SRS. The above values represent the 94-1 portion of that inventory.

The 94-1 SNF materials pose a risk to workers and the environment due to their prolonged storage in facilities and conditions that were originally intended to provide temporary storage. The structural integrity of these facilities in the case of a seismic event and the potential for release of radioactivity to the environment are of primary concern. Stabilization is being accomplished by dissolving damaged and at-risk SNF where facilities exist to carry out that operation, transferring SNF to a modern underwater storage facility, and by designing and constructing dry storage facilities at other locations. Dissolution of the Mark-16 and -22 SNF at Savannah River Site will produce a projected 1,000,000 liters of additional HEU solution, which will be stabilized along with the site's pre-existing HEU solution inventory (see Section 5.2.6).

5.3 Risk Issue Management

5.3.1 Hanford

Plutonium Finishing Plant Risk Reduction Strategy

The original 94-1 Implementation Plan developed for the Plutonium Finishing Plant (Hanford Site Integration Stabilization Management Plan) projected a completion of the plutonium stabilization activities in FY 2002. However, due to an extended period of time during which fissile material movements were suspended at the Plutonium Finishing Plant (PFP), a delay in the completion of the stabilization activities is currently projected.

During this delay, continued degradation of the PFP inventory and containers is expected, resulting in a manageable but increased level of risk to workers over time. Approximately three to seven storage containers per year require repackaging to prevent rupturing. Although a container has not ruptured in recent years, the number of items that could potentially rupture due to storage container degradation and/or material chemistry will increase with time. This poses little or no increase in risk to the public or nearby site workers, but increases risk to the PFP workers.

Richland has included in the contractor's contract the DEAR and Laws Clauses (48 CFR 970.5204-2 and 48 CFR 970.5204-78) for the integrating contractor and subcontractors to develop the infrastructure and implement Integrated Safety Management (ISM) sitewide. This involves the development of procedures and personnel training according to the principles of ISM. A strong ISM system at PFP will improve the planning, conduct and review of all work and thus improve worker safety and reduce the number of occurrences. At the facility level PFP is developing all policies/procedures to implement (Phase I verification) by April 1999 and Phase II (full implementation) by September 1999.

The following is a summary of the risks associated with the plutonium material at the PFP Plant. This information is based on the Hanford *Update on the Department of Energy's 1994 Plutonium Vulnerability Assessment for the Plutonium Finishing Plant* (HNF-3541).

Unalloyed Plutonium Metal

PFP stores 350 items of unalloyed plutonium metal. The metals have been stored in their current configuration from 15 to 30 years. This metal is typically fuels grade (16 to 18% Plutonium-240) and has a relatively high level of decay heat. Based on this decay heat information, the temperature of this metal in a can is estimated to be above the DOE-STD-3013-96 criteria of 100°C surface temperature limit for metal in permanent storage. However, ongoing revision of the long-term storage standard for plutonium (currently being drafted) may allow repackaging of these materials after brush removal of corrosion products instead of converting the entire inventory to oxide. The material that is brushed off (primarily oxides, hydrides and nitrides) would be thermally stabilized in muffle furnaces.

Included in the current inventory are a few items of plutonium metal that radiographs indicate are stored in direct contact with plastic. This configuration is known to lead to the formation of pyrophoric plutonium nitrides and plutonium hydrides. Through 1992, PFP procedures also allowed plutonium metals to be wrapped in aluminum foil, bagged-out of the glovebox, and canned in food pack cans. This placed the plutonium in the same air space as the plastic, which also may lead to the formation of plutonium hydrides and nitrides. Formation of nitrides poses a concern since it causes the depletion of the atmosphere in the can, which may lead to the collapse of the cans. If the collapse of cans causes the seals to fail and if oxygen reaches the hydrided metal, the hydrides and nitrides in the can could react vigorously resulting in worker contamination and/or contamination spread in the vault. Based on the buckling inward of some plutonium metal storage containers (estimated to be 7%), it has been concluded that plutonium corrosion products, including nitrides, have formed in some items.

Weight gains associated with approximately 5% of the metal items have been detected, indicating that air is leaking into some of the containers thus allowing the metal to oxidize. Minor bulging has also been observed in a few containers of metal stored at higher temperature locations.

Increase in Risk Associated with the Delay in Stabilization

The projected delay associated with stabilizing the unalloyed metals will result in a continuing buildup of americium-241 with an associated increase in decay heat. The delay will also lead to higher radiation levels for the material and, therefore, higher operator exposures. In addition, the increase in decay heat will elevate material temperatures, which may accelerate degradation of plutonium storage container seals and promote additional nitride formation.

Compensatory Measures

Actions taken by PFP to enhance the facility’s ability to compensate for the risks associated with unalloyed metals in storage, include the following:

- PFP has a Vault Safety Inventory System (VSIS), which is used to continually monitor part of the food pack can inventory for bulging. The VSIS will not, however, detect container failures caused by the formation of plutonium nitride, which causes cans to buckle inward. Therefore, an inspection program is currently used to ensure that the items on VSIS are visually inspected for inward buckling on an annual basis. The items not monitored by the VSIS system are visually inspected monthly.

- The unalloyed metals at PFP are stored in vault rooms restricting unnecessary worker access. The air in the vault rooms is monitored for alpha emitters by fixed head and Continuous Air Monitor (CAM) samplers, and the air in the vault is exhausted through a filtered exhaust system.

- PFP utilizes a repackaging glovebox for the handling of suspect and failed containers. When identified, these containers would be opened, the SNM inspected, and corrective actions taken. Typically the material would be repackaged and then returned to vault storage pending repackaging to satisfyDOE-STD-3013 requirements for potential shipment to Savannah River Site (SRS).

Plutonium Solutions

PFP currently stores 431 items of plutonium bearing solutions (nitrates, chlorides, caustics, and one organic). These solutions are stored in vented 10-liter containers. Ninety-nine of these items are polybottles stored in thin-walled stainless steel containers. The remaining items are Product Receiver (PR) containers in which the solutions are stored in thick-walled stainless steel vessels.

A primary concern with the storage of plutonium bearing solutions is the radiolytic decay of the solution resulting in the formation of hydrogen. If improperly vented, the hydrogen could build up to within the explosive range and/or pressurize the container causing rupture.

Another significant concern is degradation of the container (through corrosion or embrittlement) which could cause container failure and result in contamination spread. Not all solution storage containers were fabricated to the same criteria. Some PR cans were fabricated using pipe with plates welded to the ends. The design life for these containers is not known. The concentration of HCl in the chloride solutions is also unknown. Since container corrosion rates are directly related to HCl concentration, the length of time the PR can is able to contain the solution is unknown. In addition, there are ten plutonium solution storage containers which require characterization to determine the deterioration rate for these containers.

The integrity of the 99 polybottles inside the thin walled storage containers is expected to be good since no deterioration was noted during the 1995 downloading and stabilization of 27 polybottles of chloride and fluoride solutions. Although the stainless steel container surrounding a failed polybottle would contain any leaking solution for some period of time, an increased risk of worker contamination during handling or spills would exist.

All containers of solution are stored in vented configuration and triple contingency exists to preclude criticality in event of container failure.

Increase in Risk Associated with the Delay in Stabilization

Continued delay in stabilizing the solutions at PFP will result in some increase in the contamination risk during handling or cleanup due to container failure. This failure could be induced by corrosion, embrittlement, or pressurization due to a restricted vent. In 1995, polybottles were visually inspected with no apparent degradation observed. However, given the lack of more recent data regarding the condition of these containers as well as the material within, these materials are considered high risk relative to other materials.

Compensatory Measures

It is recognized that no monitoring program exists for solution containers and, therefore, no early warning mechanism for container failure and leakage exists. However, solutions will be binned according to process information and categorized based on characteristics that will impact processing. Based on the categorization, process needs will be developed and a priority scheme are being developed to stabilize solutions according to risk. Selected solutions will be processed through the prototype denitrator to develop process parameters for the production unit and/or characterized to better define risks of solutions in storage.

The compensatory actions being taken are as follows:

- Solutions at PFP are vented and stored in vault type rooms restricting unnecessary worker access.
- The air in the storage rooms is monitored for alpha emitters by fixed head and Continuous Air Monitor (CAM) samplers.
- Air in the rooms is exhausted through a filtered exhaust system.
- To guard against sparking, every container is electrically grounded and only non-sparking tools are

used to open the containers.

- Procedures require the workers to wear protective clothing and respirators during any activity that involves opening containers.

Alloyed Plutonium Metals

PFP currently stores 126 items containing plutonium alloys. Fifty-seven of these are seven percent plutonium aluminum alloys, which are considered stable.

Thirty-one of these items are plutonium-uranium alloys and 38 are miscellaneous alloys. Some of these alloys, especially the plutonium-uranium alloys, may react as unalloyed plutonium metal. Although there is no direct evidence that hydrides and/or nitrides have formed on these alloys, conditions similar to those described in the discussion of unalloyed plutonium metal could be present and brushing of hydrides and nitrides may be necessary. Many of the items were packaged prior to the issuance of PFP's storage specification and their packaging configuration is unknown. For example, items are identified as simply stored in slip lid, lard cans, or shipping containers. Through at least 1992, PFP procedures allowed plutonium alloys to be wrapped in aluminum foil then bagged out of the glovebox and canned in food pack cans. This placed plutonium alloy in the same air space as plastic, which may lead to the formation of plutonium and uranium hydrides and nitrides.

Some of the alloys also have higher plutonium-240 content than PFP's plutonium metals (up to 25.8% plutonium-240) and present the same decay heat concerns noted for the high plutonium-240 unalloyed plutonium metal.

The constituents of the miscellaneous plutonium alloy "scrap" are not identified. Many items are of non-Hanford origin, are pre-1980 packages, and have not been characterized.

Increase in Risk Associated with the Delay in Stabilization

For those alloys in which there is a potential for the formation of hydrides and nitrides, delays in stabilization will result in a slight increased risk to workers during storage and throughout stabilization.

Compensatory Measures

Current compensatory measures include:

- As described for the unalloyed metals the VSIS is used to continually monitor most food pack cans for bulging.

- An annual visual inspection is used to detect food-pack cans exhibiting inward buckling due to nitride formation.

- The alloy metals at PFP will continue to be stored in vault rooms that restrict unnecessary worker access.

- As indicated previously, the air in the vault rooms is monitored for alpha emitters by fixed head and Continuous Air Monitor (CAM) samplers and the air in the vault is exhausted though a filtered exhaust system.

- PFP will utilize a repackaging glovebox for the handling of suspect and failed alloy containers. These containers can be opened, the contents inspected and corrective action taken, the material repackaged and returned to vault for storage.

Plutonium Oxides and Mixed Oxides (> 50 wt% Pu +U)

PFP stores 2608 items of plutonium oxides (> 50 wt% plutonium) and 2297 items of mixed plutonium-uranium oxides (MOX). The majority of the oxides and MOX are relatively stable. The primary hazard associated with these oxides is potential container pressurization caused by the radiolysis of impurities, such as organics or water. Container pressurization can result in breaching and contamination spread. Since these oxides have been stabilized in the past and are routinely monitored for signs of container pressurization, the risk of this accident occurring is considered low.

PFP also stores a large quantity of oxides that contain high percentages of chloride salt impurities which may cause corrosion of storage containers and off-gas line plugging during thermal stabilization. Other oxide-related issues include; less than adequate packaging (single contamination barriers), incomplete characterization, bulging of the inner containers, and the potential for generating flammable gasses due to deterioration of the plastic used in repackaging.

Many of the MOX items were received before current acceptance criteria were established. Based on limited radiography, some MOX items have only a single metal storage can barrier between the contaminated surface of the plutonium storage container and the vault atmosphere. These items are not packaged in accordance with current requirements and the radiographs suggest that the inner storage cans have deteriorated significantly. The corrosion mechanism is unclear, but it is likely to be result of some corrosive contaminant in the MOX scrap.

Increase in Risk Associated with the Delay in Stabilization

A delay in the stabilization of the plutonium oxides and mixed oxides will result in a slight increase in risk to the workers due to potential container pressurization, continued deterioration of containers and a potential increase in hydride and nitride formation from unreacted metals.

Compensatory Measures

Current compensatory measures include:

- The oxide and MOX materials at PFP are stored in vault rooms restricting unnecessary worker access.
- As described for the unalloyed metals, the VSIS is used to continually monitor most food pack cans for bulging.
- As indicated previously, the air in the vault rooms is monitored for alpha emitters by fixed head and Continuous Air Monitor (CAM) samplers and the air in the vault is exhausted though a filtered exhaust system.
- PFP will utilize a repackaging glovebox for the handling of suspect and failed alloy containers. These containers can be opened, the contents inspected, corrective action taken, the material repackaged and returned to the vault storage.

Polycubes

PFP's inventory of polycubes consists of 260 items in vented food pack cans and polyjars. There are approximately 1,600 cubes measuring up to 8 cubic inches each. Collectively, the polycubes contain 34 kg of plutonium and 6 kg of uranium bound in a polystyrene matrix and are over 20 years old. High radiation dose fields (up to 9 R/hr on contact) have been measured. The polycubes also off-gas hydrogen and hydrocarbon gases as a result of the thermal and radiolytic decay of the polystyrene matrix. To accommodate the off-gas, the polycubes are stored in vented, filtered containers. Typically, polycubes are stored in single food pack cans that have a small hole in the top. A filter is attached to the top of the can over the hole.

A contamination spread occurred in 1987 as a result of inverting a container of deteriorated polycubes and the filter failing. The glue that held the filter in place had apparently deteriorated due to the effects of radiation and age). Since the incident, new filters have been added to the cans and movement restrictions imposed.

Increase in Risk Associated with Delay in Stabilization

The projected delay associated with stabilizing the polycubes will result in continued degradation of the structural integrity of the polycubes. The primary mechanism for the degradation of this material is through heat and secondarily through radiolysis. This degradation results in the formation of friable material which poses handling and storage risks. Additionally, the delay will allow continued degradation of the integrity of the new filter adhesive.

Compensatory Measures

As stated above, the original filters on the food pack cans and polyjars have been replaced and movement of the items has been restricted. The high radiation fields (9 R/hr) and the dose associated with handling these materials make additional characterization and other, more intrusive monitoring methods, very difficult.

Compensatory actions are as follows:

- The polycubes remain stored in vault rooms restricting unnecessary worker access.
- The air in the vault rooms is monitored for alpha emitters by fixed head and Continuous Air Monitor (CAM) samplers.
- Air in the vault is exhausted through a filtered exhaust system.
- Polycube cans/jars are vented through individual HEPA filters.
- ALARA considerations are observed in handling polycube cans/containers.

Residues (SS&C, Ash, Oxides <50 wt% Pu+U)

PFP stores 1353 items of SS&C, ash and oxides < 50 wt% plutonium and uranium. Hazards associated with these materials are similar to those of plutonium oxides with the added hazard associated with calcium metal in the SS&C, which is water reactive.

SS&C items with high plutonium assay are stored in 7-inch food pack cans. These 7-inch food pack items may also contain plutonium oxide and fluoride powders and/or plutonium metal. They may contain lab scraps and samples including fines and turnings. Further characterization of the material storage containers will be conducted.

The inventory of ash from Rocky Flats was thermally stabilized to at least 450°C, and less than one wt% LOI at PFP. This should provide sufficient stability to allow for continued storage until the material is dispositioned. The Hanford-origin ash is typically stored in taped lard cans. No specific problems have been noted with this material in storage. As with the Rocky Flats ash, this ash should be acceptable for continued storage until disposition can be accomplished.

Increase in Risk Associated with the Delay in Stabilization

A delay in the stabilization of the residues will not result in an appreciable increase in risk because the materials have historically exhibited relatively stable characteristics.

Sources and Standards

PFP stores approximately 202 items of sources and standards. The primary hazard associated with these sources and standards involves potential container pressurization caused by the radiolysis of impurities, such as organics or water, resulting in container breaching and contamination spread. These sources are relatively stable oxides and the risk of container breach is low.

Increase in Risk Associated with the Delay in Stabilization

A delay in the stabilization of the sources and standards will not result in an appreciable increase in risk because the materials consist of oxides that have been previously stabilized.

Miscellaneous Combustibles, Compounds, Scrap and Residues

PFP's inventory of miscellaneous items includes 26 items of compounds (four basic types: fluorides, Pu-Zr scrap, Pu-Be scrap, and Pu-Th scrap), 12 items of non-polycube combustibles, and 28 items of miscellaneous scrap items. The primary hazard associated with these oxides is potential container pressurization caused by the radiolysis of impurities, such as organics or water. Container pressurization can result in breaching and contamination spread. A secondary concern exists due to the potential presence of plutonium metal and/or alloys. As described in previous sections the plutonium metal and alloys have the potential to form pyrophoric compounds (hydrides and nitrides).

Increase in Risk Associated with the Delay in Stabilization

The projected delay associated with stabilization will result in some increase in risk to the workers due to continuing container and material aging and the potential increase in pyrophoric hydride and nitride formation. The total plutonium content of these items is low, therefore, the increased dose associated with the additional in-growth of americium is low.

Compensatory Measures

Actions taken to enhance PFP's ability to compensate for the risks associated with the storage of these miscellaneous items include:

- The materials remain stored in vault rooms restricting unnecessary worker access.
- As described for the unalloyed metals, the VSIS is used to continually monitor most food-pack cans for bulging.
- The air in the vault rooms is monitored for alpha emitters by fixed head and Continuous Air Monitor (CAM) samplers.
- Air in the vault is exhausted through a filtered exhaust system.
- PFP utilizes a repackaging glovebox for the handling of suspect and failed packages. These packages can be opened, the SNM inspected and corrective actions can be taken, the material repackaged and returned to vault storage.
- Characterization via records research is ongoing. This characterization will assist PFP in identifying potential problematic items.

K-Basins Risk Reduction Strategy

Richland has included the DEAR and Laws clauses in the Project Hanford Management Contract as stated in the PFP portion of this section. More specifically the K-Basins have developed facility specific policies/procedures that reflect the principles of ISM and this was validated through a Phase I verification team assessment. The Phase II (full implementation) validation is expected to be carried out in September 1999.

Hanford's K-Basins store approximately 2,100 metric tons heavy metal of spent nuclear fuel (SNF). The basins are located about 1,200 feet from the Columbia River. Hanford is a seismically active area, while the basins are not seismically qualified and are well beyond the end of their designed life. The project to initiate and complete removal of all SNF, sludge, and water from the K-Basins has been delayed from the original 94-1 commitment dates. Risk increase is directly proportional to the continued aging of the basins.

Although the basins are not currently leaking, they have been documented as leaking in the past. Their current status as non-leakers can't be documented to the satisfaction of all parties. Their weakest architectural feature is a construction joint where the basins abut the K-Reactor building. Cofferdams have been installed to prevent drainage of the basins should those joints fail. The K-Basins safety basis postulates a seismically induced structural failure. In that event, operators would attempt to minimize any leakage with bags of Bentonite clay. Fire department assistance would also be requested to provide make-up water. The basins must be kept filled with water due to the potential pyrophoricity of the SNF as it dries and to maintain shielding from the fuel's high radioactivity.

The only other effective risk mitigation is to hasten fuel removal to dry interim storage in the 200 area plateau. To this end, DOE is focused on swift, safe completion of the Hanford Spent Nuclear Fuel Project.

5.3.2 Savannah River

Risk Reduction Strategy

Safety has been and continues to be the top priority in development and execution of the SRS Nuclear Materials Stabilization and Storage (NMSS) program. With respect to the SRS 94-1 Program, this safety imperative manifests itself most directly as reduction and/or elimination of potential threat to worker/public health and safety or potential threat of environmental insult from ongoing stewardship of these materials. The SRS approach to reduction and/or elimination of potential risks associated with 94-1 materials is aligned with the five functional areas of the Integrated Safety Management System (ISMS), namely: (1) define the scope of work; (2) analyze the hazards; (3) develop and implement controls; (4) perform the work safely; and (5) feedback and assess for continuous improvement.

Savannah River has included in the contractor's contract DEAR and Laws Clauses (48 CFR 970.5204-2 and 48 CFR 970.5204-78) for the integrating contractor and subcontractors to develop the infrastructure and implement Integrated Safety Management (ISM) sitewide. More specifically, for F- and H-Canyons, the ISM verification team concluded its Phase I and Phase II verification in 1997 and will validate implementation of P 450.5 by December 1998. Implementation of ISM provides SRS with a robust safety program that can respond to urgent situations as well as identify adverse trends requiring management attention.

The remaining SRS 94-1 materials pending stabilization can be grouped according to active inventory management requirements as follows:

- <u>Solutions</u>
  F-Canyon Am/Cm solution
  H-Canyon Pu-239 solution
  H-Canyon Np-237 solution
  H-Canyon HEU solution

- <u>Materials in Vault Inventory</u>

Plutonium Metal and Oxide (>50% Assay)
Plutonium Residues and Mixed Oxides (<50%Assay)

- <u>SNF and Other Fuels and Targets in Water-filled Storage Basins</u>
  Mark-16/22 SNF
  Miscellaneous fuels/targets

The specific actions and controls for these materials within active inventory management at SRS are discussed below.

Solutions

<u>Americium/Curium Solutions:</u> The SRS inventory of special isotopes includes americium and curium (Am/Cm) in 14,400 liters of aqueous solution in a single tank in F-Canyon. A new capability and process with the ultimate goal of stabilizing the Am/Cm solution as safely and as soon as possible at the most reasonable cost is being developed. In the interim, compensatory measures have been implemented to reduce worker and environmental risk to acceptable levels.

Reviews have determined that effective controls are in place to prevent or mitigate accidents associated with the continued storage of Am/Cm in tank 17.1. The most significant of these controls are the following:

- A corrosion assessment of tank 17.1 has been completed, and a program is in place to periodically sample the tank to analyze for corrosion products and monitor corrosion rates.
- An emergency transfer route from tank 17.1 to tank 16.2 has been established to ensure that the Am/Cm solution can be safely moved should anything happen to tank 17.1.
- Solution volume in tank 17.1 is closely controlled to ensure the maximum radionuclide concentration for accident analysis calculations is not exceeded and to ensure that the full volume of 17.1 can fit into tank 16.2 if the need arises. Liquid level in the tanks is routinely monitored for unexpected changes. Action limits and required response are identified and controlled by procedure.
- Tank 17.1 has been isolated by removing all but the essential piping to and from the vessel, including the cooling water jumpers.
- Hydrogen from radiolysis is purged from the tank through the safety-significant Process Vessel Vent System.
- A backup hydrogen purge system has been installed and is continuously operated at a flow rate sufficient to dilute hydrogen in the tank vapor space below 25% of the Lower Flammability Limit (LFL).
- Potential tank leaks are contained within the canyon cell and are detected by increase in canyon cell sump level.

Several methods for stabilizing the americium-curium solutions were evaluated during development of the EIS for Interim Management of Nuclear Materials (IMNM EIS) at the Savannah River Site. In the ROD, issued December 12, 1995, the vitrification alternative was selected. Basically, the vitrification alternative is to encapsulate the Am/Cm in a glass form.

<u>Plutonium Solutions:</u> Savannah River completed stabilization of F-Canyon plutonium solutions in April 1996. Stabilization of the plutonium solutions in H-Canyon remains to be completed. Until the solutions are stabilized, an active monitoring and surveillance program is being used to maintain them in a safe

condition.

Reviews have determined that effective controls are in place to prevent or mitigate accidents associated with the continued static storage of Pu-239 solution in H-Canyon tanks 12.1 and 18.3. The most significant of these controls are the following:

- Boric acid has been added to each tank as an additional defense against accidental criticality
- Solution in each tank is periodically sampled and analyzed for chemical and radioisotope composition. Corrosion products are also monitored.
- Periodic chemical adjustments are made to maintain solution composition within approved limits.
- Steam supply to both tanks has been physically disconnected.
- All transfer lines into and out of each tank to other canyon vessels have been disconnected.
- Hydrogen from radiolysis is purged from each tank through the safety-significant Process Vessel Vent System. Installed liquid level and specific gravity instruments provide an additional source of air to dilute evolved hydrogen.
- Liquid level in each tank is routinely monitored for unexpected changes. Action limits and required response are identified and controlled by procedure.
- Potential tank leaks are contained within the canyon cell and are detected by increase in canyon cell sump level.
- Safety systems are in place to continuously monitor cooling water effluent to detect potential radioactivity release to external systems and to divert contaminated water to prevent release to the environment.

Expanded treatment, chemical adjustment, agitation, and solution movement options are available in case deficiencies occur in current storage conditions.

The fourth Supplemental ROD for the IMNM EIS calls for processing these solutions in H-Canyon to remove decay products and other material that would interfere with subsequent stabilization steps followed by transfer to HB-Line Phase II for conversion to a low-fired oxide. The plutonium oxide will be placed in temporary storage until the Actinide Packaging and Storage Facility is completed to provide the capability to meet the DOE storage standard.

Neptunium Solutions: SRS also has 6,000 liters of neptunium (Np-237) nitrate solution in H-Canyon. Np-237 has a potential for use as target material for production of Pu-238 to be used as a fuel for radioisotopic thermoelectric generators in spacecraft as well as terrestrial applications.

Reviews have determined that effective controls are in place to prevent or mitigate accidents associated with the continued storage of neptunium solution in H-Canyon tanks 9.6 and 9.8. The most significant of these controls are the following:

- Solution in each tank is periodically sampled and analyzed for chemical and radioisotope composition.
- Periodic chemical adjustments are made to maintain solution composition within approved limits.
- Steam supply to both tanks has been physically disconnected.
- All transfer lines into and out of each tank to other canyon vessels have been disconnected.
- Hydrogen from radiolysis is purged from each tank through the safety-significant Process Vessel Vent System. Installed liquid level and specific gravity instruments provide an additional source of air to dilute evolved hydrogen.

- Liquid level in each tank is routinely monitored for unexpected changes. Action limits and required response are identified and controlled by procedure.
- Potential tank leaks are contained within the canyon cell and are detected by increase in canyon cell sump level.
- Safety systems are in place to continuously monitor cooling water effluent to detect potential radioactivity release to external systems and to divert contaminated water to prevent release to the evironment.

Expanded treatment, chemical adjustment, agitation, and solution movement options are available in case deficiencies occur in current storage conditions.

In the fourth Supplemental ROD to the IMNM EIS issued on October 31, 1997, DOE decided to process the solution in H-Canyon to remove decay products and other material that would interfere with subsequent conversion steps followed by transfer to HB-Line for conversion to a low-fired oxide. Similar to the storage plan for plutonium oxide, the neptunium oxide will then be packaged and stored in the APSF.

Uranium Solutions: Prior to commencing dissolution of Mark-16/22 spent nuclear fuel, the H-Canyon and Outside Facilities held 230,000 liters of highly enriched uranium in dilute nitrate solutions. This material is the remainder of active, "in-process" solutions left after pre-1994 chemical processing and separation of spent nuclear fuel activities. An active monitoring and surveillance program is being used to maintain these solutions in a safe condition until they can be treated for long term disposition.

Reviews have determined that effective controls are in place to prevent or mitigate accidents associated with the continued storage of uranium solutions in H-Canyon and Outside Facilities tanks. The most significant of these controls are the following:

- Uranium solutions (after fission products, plutonium, and neptunium have been removed) do not generate significant amounts of hydrogen, even in highly concentrated solutions. However, tanks within H-Canyon are connected to the Process Vessel Vent System and tanks outside the canyon are connected to the Recycle Vessel Vent System.
- Solution in each tank is periodically sampled and analyzed for chemical and radioisotope composition.
- Periodic chemical adjustments are made to maintain solution composition within approved limits.
- Liquid level in each tank is routinely monitored for unexpected changes. Action limits and required response are identified and controlled by procedure.
- Potential tank leaks are contained within sumps and are detected by increase in sump level.
- Temperature of outside tanks is routinely monitored and controlled to prevent potential freezing of solution.

Expanded treatment, chemical adjustment, agitation, and solution movement options are available in case deficiencies occur in current storage conditions.

DOE has entered into a Memorandum of Understanding with the Tennessee Valley Authority (TVA) for the conversion of at least 30 MT of off-specification DOE highly-enriched uranium (HEU) to low-enriched uranium (LEU) fuel for TVA power reactors. SRS uranium solutions are part of that project. The Department is planning to blend down the solutions to less than 5 percent U-235 and then transfer them to a TVA-designated commercial fuel fabricator for conversion to power reactor fuel. TVA issued a Request for Proposals for commercial support of this project, to which responses were provided by July 1, 1998. A decision leading to an Interagency Agreement between DOE and TVA for transfer of the uranium solutions (and other off-specification HEU) should be made by early 1999, at which time a schedule for blending down and shipping to a commercial facility can be jointly developed with the chosen vendor.

Materials in Vault Inventory

Plutonium Metal and Oxide (>50% Assay): Savannah River has over 1,000 containers of high purity plutonium solids stored in F-Area vaults. Each container holds at least 100 g of fissile material that is predominantly Pu-239 with minimal impurities. The stored material includes alloys, compounds, oxides, and large metal pieces. Savannah River had accumulated these high-grade plutonium solids as a result of both F-Area facility operations and shipments received from other DOE sites. These materials were stored in a variety of containers within F-Area vaults and present extended storage concerns because of their physical condition. The degree of concern varies depending on the material form and packaging configuration. Additionally, high-assay metal and oxide will be produced from the stabilization of solutions, targets, and residues. The objective is to ensure that all plutonium metal and oxide is packaged in accordance with DOE-STD-3013-96.

Plastic packaging materials historically used in storage of these materials breakdown through radiolysis. In addition, pyrophoricity hazards can arise when hydriding of plutonium metal occurs, and personnel exposure and contamination hazards can arise through container degradation. The current SRS inventory of plutonium metal and all additional plutonium metal being produced from ongoing stabilization activities is being packaged in inner containers that meet the requirements of DOE-STD-3013-96 using a bagless transfer system installed in FB-Line in August 1997. The bagless transfer system repackages these items into welded stainless steel containers with inert helium internal atmosphere, practically eliminating the potential risks associated with the previous historical packaging system.

Several activities are underway to reduce risk until the remainder of the material can be repackaged. Reviews have determined that effective controls are in place to prevent or mitigate accidents associated with the continued storage of these materials in the FB-Line and 235-F Vaults. The most significant of these controls are the following:

- Design features of the vaults (e.g., monitors, ventilation, limited access, etc.) and radiological controls and procedures are in place to minimize worker risk in the event of container failure.
- Periodic weighing of items to detect unexpected weight gain.
- Periodic dimensional verification of containers to detect potential container deformation.
- Radiography of items to verify internal conditions.
- Radiological surveys of container surfaces to detect potential contamination release.
- Periodic Material Control and Accountability physical inspection of items.
- Periodic verification of filter functionality on containers so equipped.

Action criteria and required responses are identified and controlled by procedure. These include transfer to gloveboxes for physical sampling and interim repackaging if necessary. These actions and controls are described in detail in *A Surveillance Program to Assure Safe Storage of FB-Line and Building 235F Vault Materials, WSRC-TR-96-0413, December 30, 1996*. This program is responsive to the *DOE Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials, November 1995*.

A new Actinide Packaging and Storage Facility that will include the capability to repackage plutonium to meet the metal and oxide storage standard is being constructed. This facility, which will be available in FY 2002, incorporates bagless transfer and high temperature calcination technology for treating plutonium materials to meet the metal and oxide storage standard. This facility will include a new vault to permit consolidation of plutonium materials into a facility suitable for extended interim storage and facilitate international inspections.

Plutonium Residues and Mixed Oxides (<50%Assay): Savannah River also has over 1,200 containers of residue materials stored in the F-Area vaults that are considered to be possibly unstable and, therefore, are unsuitable for long-term storage. The degree of concern varies depending on the isotopic content, chemical impurities, and packaging.

The ES&H PlutoniumVulnerability Assessment identifies these materials as at-risk or possibly unstable. The IMNM EIS ROD, issued December 12, 1995, selected stabilization by dissolving material in F- or H-Area, purifying the plutonium in solution, and transferring the residual solution to FB- or HB-Line for conversion to a metal or oxide. The resulting metal and oxide will be handled similarly to the existing metal and oxide as discussed above. The IMNM EIS also analyzed additional stabilization options, such as processing and storage for vitrification in the DWPF.

The stabilization pathway for these materials is to fully characterize them through analytical sampling to support aqueous processing. Where material and packaging properties are currently characterized incompletely, a program will be instituted to select the required stabilization process. Methods used will include NDA using digital radiography equipment and selected sampling of containers using existing gloveboxes with modification.

Until the stabilization options can be exercised, the materials are being actively managed in vault inventory under the surveillance and monitoring program described above for plutonium metals and oxides.

SNF and Other Fuels and Targets in Water-filled Storage Basins

Mark-16/22 SNF and Miscellaneous Fuels and Targets. A structural assessment for the SRS K- and L-Reactor Disassembly Basins exterior walls and foundations determined that only minor leakage could occur through an expansion joint or cracks in the retaining walls as the result of an earthquake. A detailed structural assessment for design basis hazards was performed for RBOF in order to upgrade the safety analysis reports.

Upgrades, necessary to permit extended storage of aluminum-clad SNF in both the K- and L-Reactor Disassembly Basins, have been completed. These changes have improved the Reactor Disassembly Basins water chemistry to levels approaching RBOF. The most significant of these upgrades are the following:

- Implementation of a corrosion surveillance program.
- Reorientation of fuel from vertical to horizontal storage to eliminate galvanic coupling corrosion.
- Use of high-capacity vendor water treatment to quickly lower water conductivity from over 120 μmho/cm to less than 10 μmho/cm.

- Addition of on-line deionization capability and a deionized make-up water system.
- Completion of a series of K- and L-Basin upgrade projects in May 1996.

The Secretary of Energy described these upgrades in a January 9, 1998, letter to the DNFSB, and the DNFSB indicated their concurrence that these actions had sufficiently improved basin water quality in an April 15, 1998, letter to the Secretary of Energy.

Based upon IMNM EIS RODs, Mark-31 target stabilization was completed in March 1997, and dissolution of SRS Mark-16 and Mark-22 HEU SNF began in July 1997. The HEU SNF is being dissolved in the H-Canyon consistent with past practice. The resulting enriched uranium solutions are now transferred to the enriched uranium storage tank in the H-Area A-Line facility for temporary storage. Miscellaneous aluminum-clad targets and fuels will also be dissolved, and the resulting solutions will be transferred to the Waste Tank Farm. The eventual vitrification of radioactive material will occur in the Defense Waste Processing Facility.

5.3.3 Rocky Flats

Risk Reduction Strategy

Rocky Flats has included in the contractor’s contract DEAR and Laws Clauses (48 CFR 970.5204-2 and 48 CFR 970.5204-78) for the integrating contractor and subcontractors to develop the infrastructure and implement Integrated Safety Management (ISM) sitewide. More specifically, the ISM verification team has validated the ISM Phase I and II and P450.5 implementation for Buildings 771, 374, 707, 776, 559, and 774. The ISM system at Rocky Flats is proving its ability to continuously provide a sound safety program while responding to changes in strategy for site closure.

Plutonium Solutions in Pipes

Plutonium solutions have been drained from the tanks in Buildings 771 and 371 and stabilized. The tanks that contained measurable volumes posed the most significant risk in both buildings. The solutions that remain in process system pipes are corrosive and continue to generate hydrogen and deteriorate piping integrity resulting in leaks. These solutions present worker safety hazards from spills, and the potential for detonation and criticality. The removal and stabilization of solutions continues to be a high priority activity at Rocky Flats. System draining and piping removal activity prioritization is based on risk. In general, the actinide systems that are leaking and generating hydrogen are removed earlier. Leaking non-actinide systems are considered higher risk than non-leaking actinide systems.

Experience gained during preparation and draining the first system in Building 771 indicated that flammable concentrations of hydrogen gas should be expected in all of the process system piping / components and appropriate safety controls should be implemented. This required expanding the hydrogen safety controls which were already applied to tanks to process piping systems. Activities in the process and laboratory areas are controlled to prevent ignition sources. Tools, vacuum pumps, drain-taps and other equipment used on systems that are to be drained are 'non-spark' by design. Also, draining preparations include venting and purging operations that assure hydrogen in the piping is below the lower explosive limit.

The approach to draining piping systems is different between Buildings 771 and 371. Building 371 is only draining piping systems and Building 771 is draining and removing piping systems concurrently. The primary reason for this difference in approach is the age of the piping systems in Building 771. After draining is completed a small amount of liquid remains at joints and low points and because of the age of the joints, they continue to leak releasing radioactive material, exposing workers to unnecessary risk. Also, characterization and system status knowledge is highest immediately after draining. Therefore, a decision was made to remove the piping systems in Building 771 to eliminate the risks from leaks and accelerate equipment strip-out which supports facility closure.

The differences in approach between Building 771 and Building 371 allows Building 371 to maintain its original schedule. However, the additional work-scope in Building 771 to address hydrogen safety and remove the process system piping immediately after draining each system results in extending the tap and drain project schedule completion 39 months. This delay is acceptable since the hydrogen safety and leaking piping issues will be resolved with the piping system removed.

Sand, Slag and Crucible

Sand, Slag, and Crucible (SS&C) residues have been characterized to an 80% confidence level. Although the data at this confidence level show no hazards exist, characterization to the 95% confidence level will not be performed. The SS&C will be repackaged and shipped to the Savannah River Site (SRS) for further processing.

Further assurance that the material is not reactive is gained through resizing of the SS&C during the repackaging process and reactive metals will be further stabilized by exposure to air. Once resized, the material is packaged to SRS specifications and awaits shipping. Although the repackaged SS&C does not meet the Interim Safe Storage Criteria, shipment of all SS&C is expected to be complete by November 2000.

As a final check of the materials' stability, each package is inspected for bulging and general integrity prior to loading in the shipping container. If deficiencies are found, the package will be repackaged.

5.4 Site Safety Issue Resolution Approaches

5.4.1 Hanford

The commitments for stabilizing plutonium bearing materials described in this section represent specific disposition pathways for the various material types and their associated completion dates. In some cases enabling assumptions were made that presuppose future decisions so that specific pathways could be identified at this time. These assumptions support preferred alternatives in most cases, and are identified in the commitment statements. Since the Department is pursuing preferred alternatives, the commitments provided in this section represent the Department's best path forward for completing the necessary stabilization work. The facility level planning for all PFP stabilization activities is currently in progress. This planning effort has identified some of the key near-term decision milestones mentioned above that will drive a fully resource-loaded critical path baseline plan for stabilizing all nuclear materials at PFP.

Safety Issue 1
Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.

Hanford's 94-1 materials with the potential to become imminent safety hazards included plutonium solutions; solutions in unvented containers; certain sludges, and degraded spent nuclear fuel in water-filled storage basins. As indicated in Section 4.0, actions to stabilize a portion of the solutions, vent solution containers, and stabilize certain sludge residues were completed. Materials in this issue grouping remaining to be stabilized are the plutonium solutions in PFP and the K-Basins spent nuclear fuel.

Since 1994, plutonium metals have become a source of increasing concern due to the potential for spontaneous pyrophoric reactions and generation of flammable hydrogen. Radiographs have indicated several metal items are stored in direct contact with plastic. However, based on judgement of plutonium experts around the complex, metals will continue to be covered under Safety Issue 2.

Resolution Approach

Plutonium Solutions: PFP currently stores 431 items of plutonium-bearing solutions. These solutions are stored in vented 10-liter containers. Ninety-nine of these items are polybottles stored in thin-walled stainless steel containers. The remainder is in Product Receiver (PR) containers in which the solutions are stored in thick-walled stainless steel vessels. The primary concern with the storage of plutonium-bearing solutions is the radiolytic decay of the solution resulting in the formation of hydrogen. If improperly vented, the hydrogen could build up to within the explosive range and/or pressurize the container causing rupture. Venting of the solution containers assures pressure and hydrogen does not buildup to unacceptable levels. As an added precaution, non-sparking tools and grounding straps are used when opening the containers.

A vertical denitration calciner (VDC) has been designed to directly convert these plutonium solutions to a stable, storable oxide that minimizes personnel exposures and waste production. In the direct denitration processes used in the VDC, small additions of plutonium-bearing solutions are metered into a continuously heated and stirred bed of solids. Calcination proceeds through rapid evaporation of liquid, denitration, and final heat treatment to stable plutonium dioxide. A magnesium oxide precipitation unit is being pursued to process solutions unsuitable for the VDC and also act as a backup system to the VDC.

PFP has four general types of solutions. The largest group (~398 items) are nitric acid solutions. These solutions range from product grade solutions that can be directly denitrated in the vertical calciner to very lean, impure solutions that must be pretreated prior to denitration. The resultant oxides will be tested for compliance with DOE-STD-3013. If the resultant oxides are not compliant, they will be restabilized in furnaces using the same process described in the plutonium oxides discussion below.

The second group of solutions is the 16 chloride or chloride contaminated solution items. Depending on the chloride content, these solutions may be able to be processed in the same manner as the nitric acid solutions. If the chloride content is too high, these solutions could be diluted prior to processing in the vertical calciner or they may be precipitated and the resultant solids stabilized in furnaces.

The third group is the 16 caustic solution items. These solutions are not compatible with the vertical denitration process. It is likely that some fraction of the plutonium has already precipitated out of these solutions. PFP will need to characterize these solutions to determine how to disposition them.

The last group is the one item of organic solution. This item will require characterization prior to dispositioning.

Prior to beginning solution stabilization a “binning” scheme based on existing data will be developed. Solution types will be categorized, in order to arrive at a risk based priority scheme to stabilize all solutions. The first solution stabilization capability to come on line will be the prototype vertical calciner in May 1999, which will initiate tests required to validate some design improvements and to establish feed material specifications. During the testing of the prototype calciner 100 to 400 liters of plutonium nitrate solutions are expected to be stabilized.

At this time we are pursuing a path that will provide capability to stabilize solution through three different pathways - prototype vertical denitration calciner, production vertical denitration calciner, and magnesium oxide precipitation. The Department is considering proposals for using the precipitation process as the primary solution stabilization methodology in lieu of the vertical denitration calciner. The most promising proposal could result in a schedule shift to complete the stabilization sooner and provide cost savings. The decision for choosing the final and best path forward for solution stabilization will be made in February 1999.

Spent Nuclear Fuel: The K-East and K-West Storage Basins were constructed in the early 1950s to provide temporary storage of Single Pass Reactor fuel discharged from the K-Reactors until they were shut down in 1970. Subsequently, the basins were used for storage of N Reactor spent fuel. The basins are located approximately 1,200 ft from the banks of the Columbia River. They are unlined, concrete, 1.3 million gallon water pools with an asphaltic membrane beneath each basin. The K-East Basin presently stores approximately 1,152 t of heavy metal (MTHM). The spent fuel in K-East Basin has been stored underwater in open top canisters for periods ranging from 9 to 26 years. Fuel corrosion and environmental contaminants have produced an estimated 50 m^3 of highly radioactive sludge spread throughout the basin. The K-West Basin presently stores approximately 953 MTHM. Prior to storage in the K-West Basin, the spent fuel was placed in closed canisters. Fuel corrosion has occurred, but radioactivity and sludge has been largely contained in the closed canisters. About 20 m^3 of sludge is estimated to be in the K-West Basin. Leakage to the environment from K-East Basin has occurred, most likely at the basin discharge chute construction joint. The asphaltic membrane does not extend beneath this area. The K-West Storage Basin is not believed to be leaking. The discharge chute construction joints between the foundations of the Basins and the K-Reactors are not adequately reinforced, and a seismic event could trigger considerable leakage.

To address the urgent K-Basin issues, DOE and Hanford contractors have developed a K-Basin recommended path forward to remove the fuel from the basins, to stabilize it, and to place it in a safe, secure interim storage. The Department's decision concerning this action is consistent with the Record of Decision from the EIS for Management of SNF from the K-Basins at the Hanford Site, Richland, Washington, which was issued in March 1996. Several near term actions have been completed or are ongoing to minimize safety and environmental risks for the short time that the fuel remains in storage at the basins. These actions include installation of cofferdams to isolate the basin water from the suspected leakage site, implementation of several dose reduction measures to minimize worker exposure, upgrades to essential facilities, improvements of the conduct of operations, and characterization of fuel and sludge. The key elements of the K-Basins recommended path forward are described below:

- The K-Basins fuel and canisters will be retrieved from the current storage locations and cleaned, underwater, to remove corrosion products. The cleaned fuel will then be removed from the canisters, loaded into fuel baskets, transferred in baskets to multicanister overpacks (MCO) and vacuum dried at low temperature to remove free water. The cold vacuum dried spent fuel contained in the MCOs will be shipped to 200 East Area for interim storage in the Canister Storage Building (CSB).

- The K-Basin sludge, in addition to corrosion products generated during fuel cleaning, will be accumulated at the K-Basins and later retrieved, characterized, treated, and transferred to the Tank Waste Remediation System's 200 Area underground double shell tanks for interim storage with other waste, prior to processing and ultimate disposition. The sludge material will be managed as SNF while at K-Basins, and will be declared as waste as soon as it leaves K-Basins.

- The CSB spent fuel storage configuration will provide multiple barriers to ensure safe long-term interim storage. The spent nuclear fuel will be sealed in multicanister overpacks after appropriate monitoring to ensure worker and public protection and to minimize SNF corrosion. The CSB has been designed and constructed to achieve nuclear safety equivalency comparable to Nuclear Regulatory Commission licensed fuel storage facilities.

Other activities that have been completed or are ongoing to improve the near term safety and environmental posture at the K-Basins include:

- Installation of seismic isolation barriers (e.g., cofferdams) between the basins and the discharge chute to isolate the basin from the suspected leakage site located in the unreinforced construction joint in the discharge chute is complete. This action minimizes the potential for environmental release of radioactive contaminants either directly through the leak into the ground or by airborne release, should the basin be drained as a consequence of a seismic event. Such events could also result in significant radiological exposure to personnel during recovery actions if the water is not replaced promptly.

- An Unreviewed Safety Question (USQ) was declared concerning the existence of three 12-inch and five 4-inch drain valves in each basin. Corrective action plans, including engineered solutions are being developed to resolve this USQ.

- Performance of fuel and sludge characterization to assess fuel condition, chemical constituents, physical properties, fuel behavior during vacuum drying, and methods for treating sludge. The data will be used to support safety analyses for all planned activities and in particular to ensure safe long term storage.

- Development of a path forward for basin sludge that considers the probable differences between sludge in the fuel canisters and sludge lying on the basin floor. While the sludge contained in the fuel canisters is primarily the result of fuel corrosion, the vast majority of the sludge on the basin floor is believed to consist of sand, metallic corrosion products, and concrete chips.

- Establishment and maintenance of a formal Conduct of Operations program at the K-Basins to improve safety of ongoing operations.

- Modification of essential facility systems necessary for continued safe operations and personnel protection, such as electrical, potable water, fire protection, and maintenance systems.

- Reduction of personnel exposure in keeping with As-Low-As-Reasonably-Achievable (ALARA) practices by improving dose reduction measures and reducing the radioactive source term from cesium contaminated concrete basin walls and pipe runs.

- Removal of debris from the K-Basins, e.g., unused and empty canisters, SNF storage racks and discarded tools. This waste will be cleaned and compacted, as necessary, prior to shipment to the solid waste management area to minimize the waste volume.

- Improvement of water cleanup, including minimizing transuranic (TRU) loading of the ion exchange modules and providing redundant systems to ensure that adequate ion exchange capability is always available.

- Preparations for operational readiness to support fuel removal activities.

DOE Richland has revised the schedule and now proposes to begin fuel and sludge removal by November 2000 and July 2004, respectively, and to complete fuel and sludge removal by December 2003 and August 2005, respectively. A spent nuclear fuel project integrated schedule has been developed and approved by DOE Richland on December 14, 1998, that includes the proposed commitment dates supporting the K-basins path forward. A change package has been negotiated by the Environmental Protection Agency, Washington Department of Ecology, and DOE to establish enforceable milestones and target milestones for the project. These milestone dates agreed to have been incorporated into the project integrated schedule noted above. One of the agreements reached in the negotiations is that the SNF project schedule will be used as the basis for the 94-1 Implementation Plan milestones as well as the Tri-Party Agreement milestones. DOE is evaluating incentives to accelerate this schedule as much as possible.

Safety Issue 2
Within a reasonable amount of time, remaining materials should be stabilized and safely stored before aging causes them to become an imminent health and safety hazard to workers and the

public.

Hanford materials which fall into this category include unalloyed and alloyed plutonium metals, plutonium oxides, polycubes, residues, sources and standards, combustible residues, and miscellaneous plutonium-bearing materials. The remaining stabilization activities to address these materials are described in the following paragraphs.

Resolution Approach

Unalloyed Plutonium Metals: PFP stores 350 items of unalloyed plutonium metal. This metal is typically fuels grade (16–18 percent plutonium-240) with a high decay heat. The metals have been stored in their current configuration for 15 to 30 years. During this period of storage, the plutonium metal has apparently reacted with the atmosphere inside the can resulting in the formation of pyrophoric plutonium nitrides and hydrides. Formation of nitrides poses an additional concern since the formation of this compound causes the depletion of the atmosphere in the can. This may lead to the collapse of the cans. If the collapse of the cans causes the seals to fail resulting in oxygen reaching the hydrided metal, the hydrides and nitrides in the can could react vigorously resulting in worker contamination and/or contamination spread in the vault. Due to the high decay heat, the temperature of this metal is estimated to be above the DOE-STD-3013-96 criterion of 100°C steady state temperature limit for metal in permanent storage. Therefore, the PFP's inventory of plutonium metal would not meet DOE-STD-3013-96 criteria for metal temperature in storage and was slated for conversion to oxide. However, ongoing revision of the long-term storage standard for plutonium (currently being drafted) may allow repackaging of these materials after brush removal of corrosion products instead of converting the entire inventory to oxide.

Alloyed Plutonium Metals: PFP currently stores 126 items containing plutonium alloys. Approximately 57 of these are seven percent plutonium aluminum alloys. These plutonium-aluminum alloys are considered stable. Since these alloys are not acceptable to the MD Program, PFP is considering plans to ship them to SRS for canyon processing. NEPA considerations related to this transfer are being evaluated.

PFP also has approximately 31 plutonium-uranium alloys and 38 miscellaneous alloys. Hydrides and/or nitrides may have formed on these alloys resulting in conditions similar to those described in the discussion of unalloyed plutonium metal. PFP plans to stabilize these alloys in the same manner as the unalloyed plutonium metal. Any brushed corrosion products will be stabilized and packaged to DOE-STD-3013. Consideration will be given to discarding alloys to WIPP consistent with application to Section 308 of Public Law 105–245, 1998, and/or if they are not acceptable to the MD Program or the SRS canyon process.

Plutonium Oxides and Mixed Oxides (>50 wt% Pu+U): PFP stores approximately 2,608 items of plutonium oxides (>50 wt% Plutonium) and 2,297 items of mixed plutonium-uranium oxides (MOX). The primary hazard associated with these oxides involves potential container pressurization caused by the radiolysis of impurities, such as organics or water, resulting in container breaching and resultant contamination spread. Since these oxides have been stabilized in the past and are routinely monitored for signs of container pressurization, the risk of this accident occurring is low. A secondary concern exists with a small portion of the plutonium oxides that were formed by oxidization of plutonium metal. One of these containers has collapsed indicating that the material consumed nearly all of the available atmosphere (oxygen and nitrogen) in the can. The exact cause has not been determined but it is likely that plutonium metal fines were/are present in the oxide. These metal fines could have reacted with the air in the can to form plutonium oxides and nitrides. Formation of hydrides may also have occurred if the plastic bag in the can off-gassed.

These oxides will be thermally stabilized in muffle furnaces and packaged to meet DOE-STD-3013 criteria. Two muffle furnaces will be utilized for oxide stabilization in January 1999, and three additional furnaces will be installed in FY 1999. The BNFL stabilization and packaging system, generally referred to as the Plutonium Stabilization and Packaging System (PuSPS), may also be used to stabilize a portion of this material.

Polycubes: PFP has 260 items of polycubes composed of polystyrene cubes with plutonium and/or plutonium-uranium oxides. These items present a hazard in storage due to their off-gas generation and high radiological dose. To compensate for the off-gas, the containers of polycubes are vented. A filter is attached over the vent hole. Due to age and radiation, the glue on some of these filters has deteriorated making the filter vulnerable to being dislodged. Age and radiation has also caused the polycubes to degrade resulting in the formation of powders in the container. This powder could be dispersed if the polycube containers were handled and the filters became dislodged. To guard against this happening, movement of the polycubes is restricted.

Stabilization of polycubes is planned to be a two step process. In the first step, the polycube will be pyrolyzed in an inert atmosphere. The resulting gas discharge will be treated in an off-gas treatment process. After pyrolysis, the resultant carbon-rich oxides will be thermally stabilized in muffle furnaces to meet DOE-STD-3013. The resultant oxides will be packaged to DOE-STD-3013.

Negotiations are currently underway with LANL to install two pyrolysis furnaces either at Hanford or LANL. These furnaces have been developed and are projected to be installed in December 1999. Due to the small quantity of material associated with polycubes, it is anticipated that stabilization could be completed within one and a half years of start-up.

Residues (SS&C, Ash, Oxides <50 wt% Pu+U): PFP stores approximately 1,353 items of SS&C, Ash and Oxides < 50 wt% Plutonium and uranium. These items will be oxidized and repackaged in 3013 cans or pipe overpack, or cemented and disposed of as TRU or TRU-Mixed waste per WIPP/WAC consistent with application to Section 308 of Public Law 105–245, 1998. Hazards associated with these materials are similar to those of plutonium oxides described above with the added hazard associated with calcium metal in the SS&C. To eliminate the hazard of the calcium metal, the SS&C will be reacted with water in a controlled fashion prior to being cemented.

Sources and Standards: PFP stores approximately 202 items of sources and standards. The hazards are similar to those of oxides described above. Plutonium-beryllium sources will be shipped to LANL for dispositioning. All other sources and standards not required to support Hanford needs will be stabilized and packaged to DOE-STD-3013 using the same process as described for oxides above.

Compounds: PFP has four types of compounds in storage. PFP has approximately 12 PuF_3 and PuF_4 items as well as one PuF_3-UF_6 item. The PuF_3-UF_6 item could be thermally stabilized and packaged for shipment to SRS. This item, along with the other 12 fluorides could be shipped to SRS for canyon processing. NEPA considerations related to this transfer are being evaluated.

PFP also has three items of plutonium-zirconium scrap, six plutonium-thorium scrap, and four plutonium-beryllium scrap items. These items are less than 50 wt% Plutonium and will, therefore, be candidate items for cementation and discard.

Fuel Pins: PFP stores 138 items of un-irradiated fuel pins and assemblies. An additional 32 fuel assemblies are stored at FFTF. These fuel pins and assemblies are considered safe for interim storage pending disposition. No additional stabilization or packaging is required to meet the DNFSB Recommendation 94-1 Program requirements.

Non-polycube Combustibles: PFP has 12 items of miscellaneous non-polycube combustibles. The primary concern with these materials is their ability to pressurize their containers due to off gassing. Better characterization is required before definitive stabilization plans can be made. Two options are being considered. The primary option is to discard these items to WIPP per WIPP/WAC without treatment. If this proves impracticable, these items could be thermally stabilized using the same process as for polycubes. The resultant product could be either disposed of as TRU waste to WIPP or if the assay is >50 wt% Plutonium and uranium, the material could be packaged to DOE-STD-3013.

Miscellaneous Plutonium-bearing Materials: PFP has 28 items of miscellaneous plutonium-bearing materials. The concern with these materials is the same as for plutonium oxides. Better characterization is required before definitive stabilization plans can be made. Two options are being considered. The primary option is to discard these items to WIPP per WIPP/WAC using the process outlined for residues. If this proves impracticable, these items could be thermally stabilized using the same process as for oxides. The resultant product may be either disposed of as TRU waste to WIPP or if the assay is greater than 30 wt% plutonium and uranium, the material could be packaged to meet the revised long-term storage standard (currently being drafted).

Safety Issue 3

Research should be performed to fill any gaps in the information base needed to allow DOE to choose between alternate processes used to convert fissile materials into a form suitable for long-term storage and disposal.

Resolution Approach

Technology development needs originally existed for stabilization of Hanford's solutions, polycubes, and spent nuclear fuel. Although the baseline technologies to be used for those materials have been selected and developed as described above, characterization of 28 items of miscellaneous plutonium-bearing materials will be performed to choose the most appropriate stabilization process for those materials.

In accordance with DOE policy, the suitable container for long-term storage of plutonium metals and oxides is the DOE-STD-3013 container. Current plans are for the Richland, Rocky Flats, and Savannah River Sites to package material into the DOE-STD-3013 containers using a BNFL designed and constructed system, generally called the Plutonium Stabilization and Packaging System (PuSPS). Both the Richland and Rocky Flats DOE-STD-3013 containers are planned to be shipped to Savannah River for storage and then final disposition through the Materials Disposition (MD) immobilization pathway. At the same time, RL is committing to pursue a seal welded packaging system, similar to the Savannah River "bagless transfer" system, for purposes of maintaining DOE-STD-3013 stabilization criteria for stabilized material. The “bagless” approach allows Richland to avoid potential repackaging requirements which may be necessary in the present packaging schemes. Installing a “bagless” capability at PFP may allow the Department to pursue a final long-term packaging strategy that precludes purchasing of the PuSPS at Richland. The basis of the argument for not installing a PuSPS capability at Richland is that material stabilized into a “bagless” configuration provides a condition stabilization and interim packaging that will most assuredly maintain the DOE-STD-3013 stabilization criteria. After Richland packages material into the “bagless” configuration, shipment to Savannah River for final DOE-STD-3013 packaging through the Actinide Packaging and Storage Facility (APSF) could occur as soon as Savannah River is ready to process the Richland material. This strategy would achieve cost savings and address risk reduction desires, as well as meet the intent of DNFSB Recommendation 94-1. The decision regarding this strategy is being pursued by the Department and is expected no later than February 1999.

Deliverables/Milestones

- ***Commitment Statement:*** PFP will complete a programmatic optimization study, identifying NEPA and Regulatory requirements, for the shipping and/or processing of select 94-1 materials at alternate sites, e.g., polycubes, plutonium-aluminum alloys, fluorides, etc.. This study will identify opportunities to accelerate the mitigation of hazards/concerns for continued storage of un-stabilized plutonium materials at PFP through utilization of current capabilities at other DOE sites. The study will be documented as a disposition plan and will identify ultimate disposition approaches necessary to meet DOE-STD-3013 criteria.

  Responsible Manager: L.D. Romine, DOE-RL, Project Manager
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Decision on shipping and/or processing approach for select 94-1 materials at alternate sites.
  Due Date: February 1999

- ***Commitment Statement****:* PFP will complete evaluation of an option to mitigate the hazards/concerns of nitride and hydride formation of the stored unalloyed plutonium metal by repackaging as a metal once corrosion products have been removed by brushing. This option was recently identified as a result of PFP sponsored complex-wide workshops held during November 1998.

  Responsible Manager: L.D. Romine, DOE-RL, Project Manager
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Documented analysis and decision for processing of the inventory of unalloyed plutonium metal to meet DOE-STD-3013.
  Due Date: February 1999

- ***Commitment Statement****:* PFP will initiate mitigation of the hazards/concerns of hydrogen generation and the continued storage of plutonium solutions by testing/stabilization of these solutions to oxides in the PFP prototype vertical denitration calciner. The resultant oxides will be tested to determine compliance with DOE-STD-3013. If not compliant, the resultant oxides will be thermally stabilized.

Responsible Manager: L.D. Romine, DOE-RL, Project Manager
Applicable Facilities: Plutonium Finishing Plant
Commitment Deliverable: Initiate operation of the prototype vertical denitration calciner.
Due Date: May 1999

- ***Commitment Statement:*** PFP will complete installation of the production vertical denitration calciner to be utilized for mitigation of the hazards/ concerns of hydrogen generation and the continued storage of plutonium solutions by stabilization of these solutions to oxides.

Responsible Manager: L. D. Romine, DOE-RL, Project Manager
Applicable Facilities: Plutonium Finishing Plant
Commitment Deliverable: Complete installation of the production vertical denitration calciner
Due Date: September 1999

- ***Commitment Statement:*** PFP will complete a categorization approach to prioritize mitigation of the hazards/concerns for hydrogen generation, and the continued storage of plutonium solutions, by grouping of solutions with similar characteristics. The grouping may allow disposition directly to the Hanford Tank Farms, some cementation processing, utilization of other "small-scale" stabilization approaches. The categorization plan will also identify those solution populations that require characterization and the associated methodology.

Responsible Manager: L. D. Romine, DOE-RL, Project Manager
Applicable Facilities: Plutonium Finishing Plant
Commitment Deliverable: Documented Categorization Plan
Due Date: February 1999

- **Commitment Statement:** PFP will complete an options analysis to determine whether a magnesium oxide precipitation process should be utilized in lieu of an ion exchange pre-treatment process for those solutions that cannot be processed untreated through the production vertical denitration calciner.

Responsible Manager: L. D. Romine, DOE-RL, Project Manager
Applicable Facilities: Plutonium Finishing Plant
Commitment Deliverable: Decision on process selection for solutions that cannot be processed untreated through the production vertical denitration calciner.
Due Date: February 1999

- ***Commitment Statement:*** PFP will initiate mitigation of hazards/concerns of potential container pressurization, deterioration and incomplete oxide conversion identified for Pu oxides. Pu oxides and MOX >50 wt% Pu and/or Pu+U will be thermally stabilized and packaged to meet DOE-STD-3013.

Responsible Manager: L.D. Romine, DOE-RL, Project Program Manager

Applicable Facilities: Plutonium Finishing Plant

Commitment Deliverable: Initiate thermal stabilization of the Pu oxides and MOX >50 wt% Pu and/or Pu+U.

Due Date: January 1999

- ***Commitment Statement***: Two LANL-designed pyrolysis units will be installed at Hanford or LANL for mitigation of the hazards/concerns of off-gas generation and high radiological dose associated with the continued storage of polycubes.

  Responsible Manager: L.D. Romine, DOE-RL, Project Manager

  Applicable Facilities: Plutonium Finishing Plant

  Commitment Deliverable: Installation of two LANL-designed pyrolysis units at Hanford or another site.

  Due Date: December 1999

- ***Commitment Statement:*** PFP will identify the technical approach for mitigation of the hazards/concerns of potential container pressurization associated with the continued storage of ash residues (< 50 wt% Pu+U). The ash will be cemented or packaged in a pipe overpack component configuration (similar to the approach being pursued by Rocky Flats). It will then be disposed as TRU or TRU-Mixed waste per WIPP/WAC.

  Responsible Manager: L.D. Romine, DOE-RL, Project Manager

  Applicable Facilities: Plutonium Finishing Plant

  Commitment Deliverable: Documented approach for ash disposition.

  Due Date: January 1999

- ***Commitment Statement***: PFP will complete a cost/benefit analysis to identify use of the Hanford Convenience Can (HCC) and/or a welded seam repackaging system (similar to the bagless transfer system employed at SRS) to satisfy the requirements of the long-term storage standard for plutonium prior to repackaging in a BNFL packaging system.

  Responsible Manager: L.D. Romine, DOE-RL, Project Manager

  Applicable Facilities: Plutonium Finishing Plant

  Commitment Deliverable: Documented approach to establish an interim capability to meet the requirements of the long-term storage standard for plutonium.

  Due Date: February 1999

Plutonium Metals

- ***Commitment Statement*** The metal will be brushed and repackaged per the long-term storage standard. The resulting corrosion products will be thermally stabilized and packaged to meet DOE-STD-3013.

Responsible Manager: L. D. Romine, DOE-RL, Project Manager
Applicable Facilities: Plutonium Finishing Plant
Commitment Deliverable: Complete repackaging of metal inventory.
Due Date: May 2002

Enabling Assumptions: Brushing metals vice oxidizing is a satisfactory stabilization option for Hanford metals.

Plutonium Oxide and Mixed Oxide (>50% Plutonium and Uranium)

- ***Commitment Statement:*** Oxides will be re-stabilized, where necessary, in muffle furnaces (two on hand with an additional three installed in FY 1999) and packaged in 3013 cans. To avoid the risk of having to repackage these materials again and to promote ALARA, the procurement of a welded-seam packaging system (SRS-designed bagless transfer system) and a BNFL packaging system will be pursued.

Responsible Manager: L. D. Romine, DOE-RL, Project Manager
Applicable Facilities: Plutonium Finishing Plant
Commitment Deliverable: Complete packaging oxides
Due Date: December 2004

Plutonium Solutions

- ***Commitment Statement:*** A "binning" scheme based on existing data will be developed. Solution types will be categorized, in order to arrive at a risk based priority scheme to stabilize all solutions. Following categorization, stabilization of solutions will begin through the prototype denitrator calciner to develop design/process criteria for the production calciner which will be installed in FY 1999 and begin operation in 2000. In order to process non-nitrate solutions and as a backup to the denitration calciner, a magnesium oxide precipitation unit will be installed at PFP. The precipitate will be oxidized in muffle furnaces and packaged in 3013 cans.

Responsible Manager: L. D. Romine, DOE-RL, Project Manager
Applicable Facilities: Plutonium Finishing Plant
Commitment Deliverable: Complete solutions stabilization.
Due Date: December 2001

Enabling Assumptions: A Magnesium Oxide Precipitation Unit will be installed at PFP.

Polycubes

- ***Commitment Statement***: Polycubes will be pyrolized using a LANL designed system to be installed at Hanford or LANL in CY 1999 with the residual plutonium and uranium oxidized in muffle furnaces and packaged in 3013 cans.

  Responsible Manager: L. D. Romine, DOE-RL, Project Manager
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Complete stabilization of polycubes
  Due Date: August 2002

  Enabling Assumptions:
  1. Installation of two pyrolysis machines at another Hanford facility.
  2. Development of transportation capability for "just in time" processing at alternate Hanford site.

Plutonium Alloys

- ***Commitment Statement***: The aluminum and other selected alloys will be sent to SRS for canyon processing. Others could be brushed and packaged in 3013 cans. An options study including packaging and NEPA considerations will be conducted before final disposition of any materials offsite.

  Responsible Manager: L. D. Romine, DOE-RL, Project Manager
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Ship Alloys to SRS
  Due Date: June 2001

  Enabling Assumptions: Ability to ship aluminum and other selected alloys to SRS.

Residues

- ***Commitment Statement***: For ash and other residues, the option of packaging into a pipe overpack component like RFETS and shipment to WIPP versus cementation will be considered in applicable cases for final disposition. Consideration will be given in the disposal of residues consistent with Section 308 of Public Law 105–245, 1998.

  Responsible Manager: L. D. Romine, DOE-RL, Project Manager
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Complete packaging/stabilization of residues
  Due Date: June 2003

  Enabling Assumptions: Cleanout of cementation lines by September 1999.

Spent Nuclear Fuel

- ***Commitment Statement:*** Richland will begin fuel removal from K-Basins. The Cold Vacuum

Drying Facility and Canister Storage Building shall be ready to receive spent nuclear fuel. The spent nuclear fuel transport system shall be operable. The KW Basin spent nuclear fuel retrieval system shall begin retrieving, cleaning, and packaging spent nuclear fuel, and the First Multi-Canister Overpack of spent nuclear fuel will be loaded and transported to the Cold Vacuum Drying facility for processing.

Responsible Manager: Elizabeth D. Sellers, DOE-RL, Project Manager

Applicable Facilities: KW-Basin Facility including the fuel retrieval, integrated water treatment and cask loadout systems; Cask Transportation System; Cold Vacuum Drying Facility; and Canister Storage Building.

Commitment Deliverable: Begin fuel removal from the K-Basins.

Due Date: November 2000

- ***Commitment Statement:*** Richland will begin sludge removal from K-Basins. DOE shall complete and approve K-East sludge removal definitive design documents, all associated construction, and readiness assessments, and initiate removal of sludge from the Basin.

  Responsible Manager: Elizabeth D. Sellers, DOE-RL, Project Manager

  Applicable Facilities: K-East Basin Facility including sludge removal system; Sludge Transport System; Sludge Conditioning Facility; and K-Basin Sludge Unloading System at TWRS's double shell tank.

  Commitment Deliverable: Begin sludge removal from the K-Basins.

  Due Date: July 2004

- ***Commitment Statement:*** Richland will complete fuel removal from K-Basins. This interim milestone will be complete when all spent nuclear fuel has been removed. It is understood that additional fuel fragments may be discovered during removal of the sludge.

  Responsible Manager: Elizabeth D. Sellers, DOE-RL, Project Manager

  Applicable Facilities: K-Basins Facility including the fuel retrieval, integrated water treatment and cask loadout systems; Cask Transportation System; Cold Vacuum Drying Facility; and Canister Storage Building.

  Commitment Deliverable: complete fuel removal from the K-Basins.

  Due Date: December 2003

- ***Commitment Statement:*** Richland will complete sludge removal from the K-Basins.

  Responsible Manager: Elizabeth D. Sellers, DOE-RL, Project Manager

  Applicable Facilities: K-Basins Facility including sludge removal system; Sludge Transport System; Sludge Treatment Facility; and K-Basin Sludge Unloading System at TWRS's double shell tank.

  Commitment Deliverable: Complete sludge removal from K-Basins.

  Due Date: August 2005

5.4.2 Savannah River

Safety Issue 1

Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.

Resolution Approach

Materials at SRS that fell under Safety Issue 1 were plutonium solutions; metal in contact with plastic; Pu-238 solids; special isotope solutions; and uranium solutions. As previously described in section 4.1, F- Canyon Pu-239 solutions, metal suspected to be in contact with plastic, Pu-238 solids, and Pu-242 solutions have already been stabilized. Risk mitigation actions which have been taken for the remaining Pu-239 solutions and special isotope solutions are described in Section 5.3.

Plutonium Solutions: Savannah River completed conversion of F-Canyon plutonium solutions in April 1996. The plutonium metal produced by stabilizing solutions in the FB-Line is being packaged in inner containers that meet the requirements of DOE-STD-3013-96 using a bagless transfer system. Savannah River completed installation of a bagless transfer system in the FB-Line facility in August 1997 as a demonstration of the new packaging technology. Outer container packaging will be completed when the Actinide Packaging and Storage Facility becomes available.

Stabilization of the plutonium solutions in the H-Canyon remains to be completed. Until the solutions are stabilized the major area of concern is control of solution chemistry. Due to evaporation and radiolysis, solution chemistry requires periodic adjustments to avoid unanticipated concentration or precipitation of boron and ultimately the plutonium compounds, which may increase the potential for inadvertent criticality. Boron was added as a neutron poison and solution chemistry is adjusted to avoid precipitation of the boron and ultimately the plutonium. An increased sampling and surveillance program is in place to detect signs of deterioration. Minor leaks and spills are not a major concern since they will be contained within the canyons and fed back into the tanks without exposing the workers or posing a risk to the environment or public. Corrosion of tank cooling water coils poses a risk of environmental release. This risk is mitigated by the use of in-line radiation detectors and diversion pools, which would be employed in the event of a leak.

The _Interim Management of Nuclear Materials Environmental Impact Statement_ identifies a preferred alternative for stabilization of the Pu-239 solutions in the H-Canyon. The action indicated in the Record of Decision is to process the solution in H-Canyon to remove decay products and other material that would interfere with subsequent stabilization steps followed by transfer of Pu-239 to HB-Line Phase II for conversion to a low-fired oxide. The plutonium oxide will be placed in temporary storage until the Actinide Packaging and Storage Facility is completed to provide the capability to meet the DOE storage standard.

Based on progress to date toward the multiple facility restarts required to implement the Phased Canyon Strategy, and incorporation of lessons learned from five successful Operational Readiness Reviews, H-Canyon plutonium solution stabilization is expected to begin by July 2001 and be completed by June 2002. Safety of continued storage of the H-Canyon plutonium solutions until stabilization is complete has been enhanced through additional sampling and monitoring activities.

Metal in Contact with Plastic: Based on material and packaging information available in 1995, 12 containers of metal turnings where plutonium metal was in direct contact with plastic have been repackaged. These materials will be dissolved and processed to metal using the F-Canyon and the FB-Line facilities. (See residues discussion under Safety Issue 2, below.)

Americium/Curium Solutions: Savannah River's inventory of special isotopes includes americium-243 and curium-244 (Am/Cm) in 14,400 L of aqueous solution in a single tank in F-Canyon. Stabilization of the solution could not be accomplished within the 3-year period recommended by the Board in 1994 because of the lack of capability and process. A process installed in F-Canyon was used in the early 1980s to convert small quantities of americium-241 to an oxide. However, the process equipment has not been maintained and requires extensive modification to restore it to use. A new capability and process with the ultimate goal of stabilizing the Am/Cm solution as safely and as soon as possible at the most reasonable cost is being developed. In the interim, because of the urgency of the storage conditions, DOE has implemented compensatory measures to reduce worker and environmental risk to acceptable levels.

Reviews have determined that effective controls are in place to prevent or mitigate accidents associated with the continued storage of Am/Cm in tank 17.1. The most significant of these controls are the following:

- Tank 17.1 has been isolated by removing all but the essential piping to and from the vessel, including the cooling water jumpers.
- A backup hydrogen purge system has been installed and is continuously operated at a flow rate sufficient to dilute hydrogen in the tank vapor space below 25 percent of the LFL.
- A corrosion assessment of tank 17.1 was completed and a program is in place to periodically sample the tank to analyze for corrosion products and monitor corrosion rates.
- An emergency transfer route from tank 17.1 to tank 16.2 has been established to ensure that the Am/Cm solution can be safely moved should anything happen to tank 17.1.
- Solution volume in tank 17.1 to tank 16.2 is closely controlled to ensure the maximum radionuclide concentration for accident analysis calculations is not exceeded and to ensure that the full volume of 17.1 can fit into tank 16.2 if the need arises.

Several methods for stabilizing the americium-curium solutions were evaluated during the development of the IMNM EIS. In the fourth Supplemental ROD for the IMNM EIS the vitrification alternative was selected and published in the subsequent EIS Record of Decision. Basically, the vitrification alternative is to encapsulate the Am/Cm in a glass form.

An Americium/Curium Demonstration Project for vitrifying the Am/Cm solution has been in development since 1995, but development of a suitable melter has proven to be a more formidable problem than originally estimated. As a result, the project has had to be reassessed. Design and construction activities related to vitrification were curtailed in the Fall of 1997, and the Research and Development (R&D) activities were reformulated to focus on a different method to achieve vitrification. The Resistance-Heated Bushing Melter: Continuous Feed, Semi-continuous Pour method has subsequently been replaced with an Induction-Heated Cylindrical Melter: Batch Feed-Batch Pour method. This R&D has been completed with design basis data/information planned to be used to revise the Design Basis Documents and rebaseline the project. Preliminary design is planned to restart in the Spring of 1999, and the cost and schedule baseline is planned to be approved in July/August 1999. Meanwhile, the Savannah River Technology Center is examining potential alternatives to be used in case the Cylindrical Induction Melter process fails to mature. Alternatives that are available for consideration are an In-Can Vitrification Process (mixing of low temperature frit with the oxalate precipitate within the can and directly heated), an In-Can Oxide Process, or a Silica-Gel Process (absorption on Si-Gel and calcining to ceramic or calcining/vitrifying as a glass).

Stabilization, packaging, storage and shipping alternatives for the material have also been reevaluated. Vitrification has again been determined to be the most viable stabilization process, but options for packaging, storing, and shipping continue to be assessed.

Neptunium Solutions: Savannah River has 6,000 L of neptunium (Np-237) nitrate solution in H-Canyon. Np-237 has a potential for use as target material for production of Pu-238 to be used as a fuel for radioisotope thermo-electric generators in spacecraft as well as terrestrial applications.

In the fourth Supplemental ROD to the IMNM EIS, issued on October 31, 1997, DOE selected the solution in H-Canyon to remove decay products and other material that would interfere with subsequent conversion steps followed by transfer to HB-Line for conversion to a low-fired oxide. Similar to the storage plan for plutonium oxide, the neptunium oxide will then be packaged and stored in the APSF. These activities will be completed by December 2005.

While the neptunium solution awaits disposition, activities to reduce the potential for release to the environment include an expanded and formalized sampling and monitoring program; pressurization and monitoring of the cooling water supplied to the solution storage vessel; and monitoring of the cooling water effluent to ensure no radioactivity is released to external systems. Expanded treatment, chemical adjustment, agitation, and solution movement options are available in case deficiencies occur in current storage conditions.

During the neptunium solution stabilization, Savannah River also plans to solidify any neptunium recovered during stabilization of plutonium residues and mixed oxides, irradiated fuels, and from dissolving the unirradiated neptunium-aluminum reactor targets that are currently stored at the site.

Uranium Solutions: Prior to commencing dissolution of Mark-16/22 spent fuel, the H-Canyon processing facility at Savannah River held 230,000 L of highly enriched uranium in dilute nitrate solutions. This material is the remainder of active, "in-process" solutions left after pre-1992 chemical processing and separation of spent nuclear fuel activities. The solutions are not suitable media for long-term storage of excess uranium, however, an active monitoring and surveillance program is being used to maintain them in a safe condition until they can be treated for long term disposition.

DOE has entered into a Memorandum of Understanding with the Tennessee Valley Authority (TVA) for the conversion of at least 30 t of off-specification DOE highly enriched uranium (HEU) to low-enriched uranium (LEU) fuel for TVA power reactors. The 230,000 L of Savannah River HEU solutions are part of that project. The Department is planning to blend down the solutions to less than 5 percent U-235 and then transfer them to a TVA-designated commercial fuel fabricator for conversion to power reactor fuel. TVA issued a Request for Proposals (RFP) for commercial support of this project, to which responses were provided by July 1, 1998. Modifications that refine and simplify TVA's RFP are pending.

A decision leading to an Interagency Agreement between DOE and TVA for transfer of the uranium solutions (and other off-spec HEU) should be made by early 1999, at which time a firm schedule for blending down and shipping to a commercial facility will be finalized. Project planning is based on a schedule developed collaboratively by DOE and TVA. Under the schedule in its current form, shipments from SRS to a commercial facility of LEU solutions derived from HEU covered by the 94-1 Implementation Plan would begin in Spring 2001 and end in December 2003.

SRS continues to evaluate alternative options for stabilization of HEU solutions (e.g., blending to less than one percent uranium-235 and conversion to a solid) in the event that the anticipated TVA arrangement cannot be negotiated successfully.

Safety Issue 2

Within a reasonable amount of time, remaining materials should be stabilized and safely stored before aging causes them to become an imminent health and safety hazard to workers and the public.

Resolution Approach

The remaining materials at Savannah River not covered under Safety Issue 1 are the metals and oxides, residues, and the remaining Mark-16/22 SNF. Also, DOE's preferred alternative the August 1998 *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology site (RFETS Residue EIS)* for scrub alloy; sand slag and crucible; and plutonium fluorides is stabilization at SRS. Stabilization plans for all of these materials are described in the following paragraphs.

<u>Plutonium Metal and Oxide:</u> Savannah River has approximately 1,000 containers of high purity plutonium solids stored in F-Area vaults. Each container holds at least 100 g of fissile material that is predominantly Pu-239 with minimal impurities. The stored material includes alloys, compounds, oxides, and large metal pieces. Savannah River had accumulated these high grade plutonium solids as a result of both F-Area facility operations and shipments received from other DOE sites. These materials were stored in a variety of containers within F-Area vaults and present extended storage concerns because of their physical condition. The degree of concern varies depending on the material form and packaging configuration. Additionally, over 300 containers of metal and oxide will be produced from the stabilization of solutions, targets, and residues and will also require packaging and treatment to meet the metal and oxide storage standard. The objective is to ensure that all pre-existing plutonium solids (metal and oxide) are in conformance with the DOE metal and oxide standard by May 2002, assuming a December 2001 startup of APSF.

Several activities are underway to reduce the risk until the material can be repackaged. Design features of the vault (e.g., monitors, ventilation, limited access, etc.), and radiological controls and procedures are in place to minimize the worker risk in the event of a container failure. Surveillance and monitoring programs include statistical sampling to check for weight gain and visual checks for bulging. To select the required treatment and the priority for treatment, the containers will be non-destructively characterized using digital radiography equipment. Sampling of containers using existing gloveboxes will also be performed as warranted.

A new Actinide Packaging and Storage Facility that will include the capability to repackage plutonium to meet the metal and oxide storage standard is being constructed. This facility incorporates bagless transfer and high temperature calcination technology for treating plutonium materials to meet the metal and oxide storage standard. This facility will include a new vault to permit consolidation of plutonium materials into a facility suitable for extended interim storage and facilitate international inspections.

It had been anticipated that this facility would be available in FY 2002, but a number of factors have resulted in the delay now contemplated. First, further refinement of the facility design has resulted in significant increases in the total project cost. Also, there are some remaining facility requirements that must be evaluated and finalized in the design. Finally, there are significant budget challenges at Savannah River emerging from new facility requirements in excess of the previous baseline funding profile. These factors require that the pace of the project be adjusted to allow closure of project uncertainties and to deal with constrained Site funding. The Department is committed to look at means by which some of the APSF schedule can be recovered. A delay in APSF startup does not result in a degradation of the safety posture related to storage of plutonium metals and oxides.

Rocky Flats Classified Plutonium Metal: One of the alternatives analyzed in the draft Surplus Plutonium Disposition EIS is shipment of classified plutonium metal from RFETS to SRS where it would be recast in FB-Line similarly to SRS miscellaneous plutonium metal. The total quantity of material involved and schedule remain to be finalized.

Residues: Savannah River identified residues in eight categories: 1) plutonium sweepings (202 containers); 2) plutonium turnings (37 containers); 3) Sand, Slag, and Crucibles (128 containers); 4) miscellaneous plutonium metal (10 containers); 5) miscellaneous plutonium alloy (18 containers); 6) mixed scrap (260 containers); 7) plutonium scrap (340 containers); and 8)DU/Pu (5 containers [1200 RODs, 2 MTU]). These materials have been stored in the F-Area vaults and are considered to be possibly unstable, and therefore, are unsuitable for long-term storage. The degree of concern varies depending on the isotopic content, chemical impurities, and packaging.

The ES&H Plutonium Vulnerability Assessment identifies these materials as at-risk or possibly unstable. The IMNM EIS ROD, issued in December 1995, selected stabilization by dissolving material in F- or H-Area, purifying the plutonium in solution, and transferring the residual solution to FB- or HB-Line for conversion to a metal or oxide. For example, dissolution of pre-existing sand, slag and crucible residue in F-Canyon was completed in July 1998, and stabilization to metal in FB-Line will be completed by September 1999. The IMNM EIS ROD also included the additional stabilization options of improving storage and vitrifying the materials in F-Canyon. The fourth Supplemental Record of Decision issued October 31, 1997, added processing and storage for vitrification in the DWPF as another stabilization method.

The stabilization pathway for these materials is to repackage the items that are greater than 100 g to meet requirements of the long-term storage standard and to stabilize the other materials via aqueous processing. Until the stabilization options can be exercised, the materials are under a surveillance and monitoring program that includes visual inspection and statistical sampling. The design features of the vault minimize worker risk in a packaging failure.

Where material and packaging properties are characterized incompletely, a program will be instituted to select the required stabilization process. Methods used will include NDA using digital radiography equipment installed in March 1997, and selected sampling of containers using existing gloveboxes with modification. Full material characterization capability is expected to be in place by June 1999.

Current plans call for the repackaging of all existing high-grade, mixed plutonium solids (>100 g/can) to meet the current or revised metal and oxide storage standard. These plans assume that the new

Actinide Packaging and Storage Facility (APSF) will be available. This new facility will include a new vault to permit consolidation of existing on-site plutonium materials into a single facility.

Other possibly unstable residues which are slated for processing include the mixed, low-grade solids in the HB-Line. The material processed in HB-Line will be transformed to oxide. Other activities will be completed to have all residue materials meet the requirements of the storage standard by September 2004.

Rocky Flats Scrub Alloy: In accordance with the RFETS Residue EIS ROD, the existing scrub alloy at RFETS will be shipped to SRS where it will be dissolved in F-Canyon. The plutonium recovered will be processed through F-Canyon and transferred to FB-Line for conversion to metal and packaging for storage in the APSF. The Material Transfer Project, which identifies Rocky Flats Closure Project Management Plan Shipper/Receiver Agreements between Rocky Flats and Savannah River Site [(September 8, 1998, memorandum from J. Roberson (DOE-RF) and G. Rudy (DOE-SR) to J. Owendoff (EM-1), established a target of November 1999 for completion of transfer of RFETS scrub alloy to SRS for stabilization.

Rocky Flats Residues: In accordance with the RFETS Residue EIS ROD, the sand, slag, and crucible (SS&C) at RFETS will be prepared, packaged, and shipped to SRS where it will be dissolved in F-Canyon similarly to the inventory of SS&C at SRS. The plutonium recovered will be processed through F-Canyon and transferred to FB-Line for conversion to metal and packaging for storage in the APSF. The Material Transfer Project established a target of November 2000 for completion of transfer of RFETS SS&C to SRS for stabilization.

In accordance with the RFETS Residue EIS ROD, the plutonium fluorides at RFETS will be prepared, packaged, and shipped to SRS. Those meeting compatibility requirements will be added to the FB-Line reduction furnace charge for processing as has been demonstrated for certain SRS plutonium residues. The remainder will be dissolved in F-Canyon, and the plutonium recovered will be processed through F-Canyon and transferred to FB-Line where it will be converted to metal and transferred for storage to the APSF. The Material Transfer Project established a target of September 2000 for completion of transfer of RFETS plutonium fluorides to SRS for stabilization.

Hanford Materials: The Department is investigating options for offsite stabilization of some of Hanford's 94-1 materials. Some of those materials, namely plutonium-aluminum alloys and fluorinated residues, may be sent to Savannah River Site for canyon processing. See Section 5.4.1 for additional discussion of studies being performed. If sent to SRS, stabilization of these materials would need to be integrated into current canyon schedules.

Spent Nuclear Fuel: The K- and L-Reactor Disassembly Basins are unlined, concrete water pools that store spent fuel, target assemblies, and other radioactive material. The basins have been in operation since 1954 and hold 3.5 to 4.5 million gallons each. With the Mark-31 targets having been stabilized, the inventory of SNF in the basins consists of approximately 1,800 Mark-16 and Mark-22 spent fuel elements containing 7.2 t of heavy metal. The extended duration of storage, poor water chemistry control, galvanic coupling, damaged cladding due to handling, and lack of appropriate water filtration systems all contributed to accelerated corrosion of the spent nuclear fuel and target materials and increased radioactivity levels in the water of the Basins. Additionally, the facilities were not designed to meet current seismic standards, and the current leak detection method is not sufficiently sensitive to detect small leaks.

The Receiving Basin for Off-Site Fuels (RBOF) Facility stores reactor fuel elements from off-site reactors and occasionally from on-site reactors. The RBOF is a concrete pool with a volume of approximately 500,000 gallons. Placed into operation in 1963, it has a stainless steel bottom and Phenoline resin-coated walls. The original design incorporated a basin water chemistry control system consisting of a filter and mixed ion-exchange resin deionizer system. The fuel elements in the RBOF, some of which have been in the basin for 30 years, show no visible signs of corrosion. The fuel assemblies, canisters of fuel, and targets are stored at RBOF in storage racks that provide the spacing required to preclude nuclear criticality. Fuel consolidation to provide approximately 1,250 additional RBOF storage spaces was completed in August 1996.

Savannah River has traditionally processed highly enriched uranium (HEU) SNF in the H-Canyon and plutonium production targets, which are irradiated depleted uranium (less than 0.2 percent U-235), through the F-Canyon. The separated enriched uranium produced in H-Canyon was traditionally transported to Oak Ridge as enriched uranyl nitrate solution for recycling into new fuels for SRS reactors. The depleted uranium produced in the F-Canyon as a by-product of the plutonium separations process was traditionally converted to oxide in the F-Area A-Line facility.

Based upon the IMNM EIS RODs, Mark-31 target stabilization was completed in March 1997, and dissolution of SRS Mark-16 and Mark-22 HEU SNF began in July 1997. The HEU SNF is being dissolved in the H-Canyon consistent with past practice. The resulting enriched uranium solutions are now transferred to the enriched uranium storage tank in the H-Area A-Line facility for temporary storage. Miscellaneous aluminum-clad targets and fuels will also be dissolved, and the resultant solutions will be transferred to the Waste Tank Farm. The eventual vitrification of radioactive material will occur in the Defense Waste Processing Facility. Sufficient tank volume exists to handle the projected waste steams.

A structural assessment for the K- and L-Reactor Disassembly Basins exterior walls and foundations determined that only minor leakage could occur through an expansion joint or cracks in the retaining walls as the result of an earthquake. A detailed structural assessment for design basis hazards was performed for RBOF in order to upgrade the safety analysis reports.

Upgrades, necessary to permit extended storage of aluminum-clad SNF in both the K- and L-Reactor Disassembly Basins, have been completed. These changes have improved the Reactor Disassembly Basins water chemistry to levels approaching RBOF. Additionally, vertically stored fuel in K- and L-Reactor Disassembly Basins was reoriented to eliminate galvanic coupling and associated storage equipment corrosion.

Safety Issue 3

Research should be performed to fill any gaps in the information base needed to allow DOE to choose between alternate processes used to convert fissile materials into a form suitable for long-term storage and disposal.

Resolution Approach

As discussed under Safety Issue 1, development of a stabilization process for Savannah River's americium/curium solutions has been ongoing since 1995. A technology evaluation and independent review were conducted in 1998 that reconfirmed vitrification as the preferred technology for stabilization, but also recommended that options for stabilization to an oxide as a backup alternative continue to be studied. A rebaselining of the Am/Cm stabilization program will be completed in June 1999.

Deliverables/Milestones

Solutions

- ***Commitment Statement:*** Complete stabilization of 34,000 liters of Pu-239 solutions in H-Canyon.
  Responsible Manager: William Dennis, DOE-SR
  Applicable Facilities: H-Canyon and HB-Line
  Commitment Deliverable: 34,000 liters of H-Canyon Pu-239 solutions converted to oxide.
  Due Date: June 2002

Metal and Oxide >50% Plutonium

- ***Commitment Statement:*** Complete construction of the APSF and fully prepare it for storing SNM.
  Responsible Manager: Guy Girard, DOE-SR
  Applicable Facilities: APSF
  Commitment Deliverable: APSF operational.
  Due Date: December 2001-December 2003
  (Construction completion depends on resolution of technical issues and funding availability. DOE will prioritize funding to ensure that the highest risk materials are addressed first. DOE will ensure that potential delay in APSF construction will not result in a degradation of the safety posture at SRS or other sites.)

- ***Commitment Statement:*** Repackage all pre-existing SRS plutonium metal and oxide to meet the metal and oxide storage standard.
  Responsible Manager: Allen Gunter, DOE-SR
  Applicable Facilities: APSF
  Commitment Deliverable: All SRS plutonium metal and oxide from May 1994 inventory repackaged to meet the metal and oxide storage standard.
  Due Date: May 2002
  (Commitment linked to December 2001 startup of APSF.)

Residues <50% Plutonium

- ***Commitment Statement:*** Complete stabilization and packaging of solutions from dissolution of SRS plutonium residues.
  Responsible Manager: Allen Gunter, DOE-SR
  Applicable Facilities: F-Canyon, FB-Line, HB-Line, and APSF

Commitment Deliverable: All SRS plutonium residues from May 1994 inventory stabilized and repackaged to meet the metal and oxide storage standard.
Due Date: September 2004
(Commitment linked to December 2001 startup of APSF.)

Special Isotopes

- ***Commitment Statement:*** Complete vitrification of Am/Cm solutions.
  Responsible Manager: Sachiko McAlhany, DOE-SR
  Applicable Facilities: F-Canyon/Multi-Purpose Processing Facility
  Commitment Deliverable: Vitrify May 1994 inventory of Am/Cm solution stored in F-Canyon.
  Due Date: September 2002

- ***Commitment Statement:*** Complete stabilization of Np-237 solutions.
  Responsible Manager: William Dennis, DOE-SR
  Applicable Facilities: HB-Line, H-Canyon and APSF
  Commitment Deliverable: Np solution converted to stable oxide.
  Due Date: December 2005
  (Stabilization of Np-237 solution must be close coupled to availability of long-term storage space to reduce personnel exposure caused by radiation from decay daughter in-growth. Commitment is linked to December 2001 startup of APSF.)

Uranium

- ***Commitment Statement:*** Complete disposition of pre-existing enriched uranium solutions and enriched uranium solution resulting from Mark-16 and Mark-22 SNF dissolution.
  Responsible Manager: William Dennis, DOE-SR
  Applicable Facilities: H-Canyon and HA-Line
  Commitment Deliverable: All enriched uranium solutions dispositioned.
  Due Date: December 2003

Spent Nuclear Fuel

- ***Commitment Statement:*** Complete Mark-16 and Mark-22 SNF dissolution.
  Responsible Manager: William Dennis, DOE-SR
  Applicable Facilities: H-Canyon
  Commitment Deliverable: Mark-16 and Mark-22 SNF dissolved.
  Due Date: December 2001

RFETS Residues and Scrub Alloy

- ***Commitment Statement:*** Complete stabilization and packaging of RFETS plutonium residues and scrub alloy for long-term storage.
  Responsible Manager: Allen Gunter, DOE-SR
  Applicable Facilities: F-Canyon, FB-Line, 235-F and APSF
  Commitment Deliverable: RFETS plutonium residues and scrub alloy converted to stable metal and packaged to meet the metal and oxide storage standard.
  Due Date: May 2002
  (Commitment linked to the December 2001 startup of APSF.)

5.4.3 Rocky Flats

Safety Issue 1
Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.

Resolution Approach

Rocky Flats' share of 94-1 materials with the potential to become imminent safety hazards included plutonium and uranium solutions; plutonium metal in contact with plastic; residues in unvented drums and some residue material categories (e.g., salts and graphite fines). As discussed in Section 4.0, all metal in contact with plastic has been repackaged, all drums containing plutonium residues have been vented and uranium-bearing solutions have been shipped to an off-site vendor and stabilized. Furthermore, graphite fines and some salt residues have been recharacterized as low risk materials.

Plutonium Solutions: Plutonium solutions originally existed in Buildings 371, 559, 771, 776/777, and 779, with the majority being in Buildings 371 and 771. These original solutions have been removed from Buildings 776/777 and 779. While the remaining solutions await stabilization, several interim measures have been taken to minimize the risks of continued storage. Solutions stored in plastic bottles have been transferred to gloveboxes and vented to decrease the rate of degradation and inspected to identify incipient failures in time to replace the bottles. Building 771 and Building 371 tanks have been drained, solution stabilized, and tap and draining of process systems has been initiated. Access to areas where the potential for leakage from tanks or pipes exists is strictly controlled. Alarm systems are in place to detect airborne contamination from spills or leaks and alert personnel. Piping system flanges and valves have been encased in plastic shrink wrap to provide an additional barrier between the solutions and the workers.

The plutonium in these solutions is surplus to DOE's needs. Therefore, Rocky Flats is solidifying as many solutions as possible through cementation. Some higher level solutions require an additional precipitation step to remove the plutonium from the waste stream in order to meet waste disposal acceptance criteria and waste minimization goals.

The solutions that had been stored in Buildings 559, 776/777 and 779 have been transferred to Building 771 for batching or Building 371 for processing as appropriate. Building 559 continues to generate small quantities of low-level waste solutions due to analytical analysis to support Site closure. Low-level solutions in Building 771, including holdup drained from piping systems and low-points, are being batched and transferred to Building 774 for cementation. Cementing the low-level solutions began in October 1993, and to date over 6100 liters have been solidified. The high-level uranium and chloride solutions have been processed in Building 771 using a hydroxide precipitation method. The filtrates from that process were cemented in Building 774. The high-level (>6.0 gm/L) plutonium solutions in Building 771 tanks have been drained to bottles. The high-level solution bottles have been processed through the Caustic Waste Treatment System in Building 371, which is also a hydroxide precipitation process. Solutions from Building 771 tap and draining that are compatible with the Caustic Waste Treatment System process will be stabilized in Building 371.

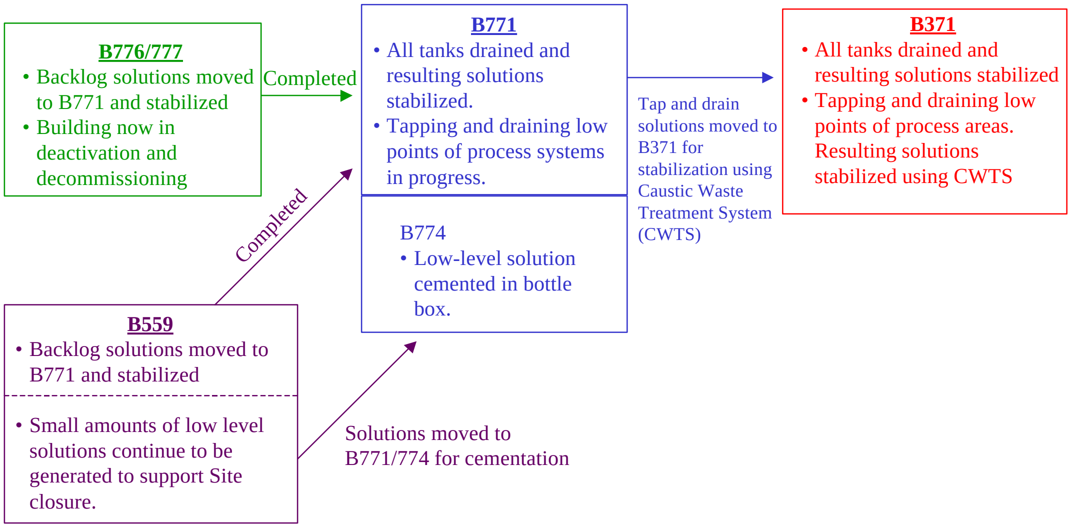
Delays resulting from unexpected conditions encountered during tap and draining of the first process system in Building 771 (as discussed in Section 5.3) have necessitated a revision to the tap and drain plans for building 771. New plans have been developed which incorporate additional safety controls (primarily system venting and purging for hydrogen) during tap and draining activities. Additional work scope has been developed to accelerate removal of process system piping immediately after system draining in Building 771. This work is scheduled to be completed by December 2001.

Justification and rationale for the Building 771 work scope increase and schedule delay
This change in strategy (1) eliminates the possibility of residual liquid remaining in piping after draining; (2) eliminates recharacterization of piping which would be necessary after a delay between draining and removal; and (3) accelerates process equipment removal activities of Building 771 in support of accelerated site closure. While the most significant risks have been alleviated by draining the solution inventory from the process tanks, additional risk reduction progress is being continued and integrated with the Building 771 closure activities. Prioritization of process system piping draining and removal is based on the following risk factors: (1) leaking, (2) hydrogen generation, and (3) actinide concentration. Detailed schedules have been developed that support completion by December 2001, with six and eight actinide systems to be drained in 1999 and 2000, respectively.

The solutions from Building 371 tap and draining and remaining compatible solutions from other buildings continue to be treated in the Caustic Waste Treatment System. The precipitate is being calcined and placed in temporary storage awaiting safe interim storage. The effluent is being transferred to Building 374 for further liquid waste processing. The solutions in Building 371 which were originally scheduled to be stabilized by June 1999 with the Building 771 solutions, are still expected to be drained from the areas in Building 371 and processed by June 1999. However, the impact of delays in Building 771 tap and draining will result in processing liquids from Building 771 beyond June 1999.

The liquid stabilization program will be integrated with current efforts to meet the safe storage criteria, DOE-STD-3013-96 for the plutonium oxides generated as a result of the stabilization process. The oxide, generated prior to obtaining the capability to meet the criteria in DOE-STD-3013-96 will be packaged to meet site storage requirements. See Figure 5.4.3-1 for a simplified flow diagram.

Figure 5.4.3-1: Plutonium Solution Stabilization Process Flow Diagram



Residues: The Rocky Flats Environmental Technology Site has an inventory of approximately 106 metric tons of residues packaged in 3,930 55-gallon drums and 3,950 containers. These residues contain approximately 3 metric tons of plutonium and are stored in buildings 371, 707, 776, and 777. Most of these residues were originally classified as high risk. However the majority have been or are being reclassified as low risk due to accomplishing actions that lowered their contained storage risk (i.e., venting of drums) and due to extensive characterization of the residues during 1997 and 1998.

For most categories of residues, some form of stabilization or separation was thought to be needed in order to meet interim storage requirements, disposal requirements, or to terminate safeguards. Through characterization, innovations such as the pipe component, safeguards termination limit variances, and process refinements, acceleration of residue repackaging and removal is possible. Improvements in the IP milestone dates are proposed and the plan is now integrated to support Site closure. Only a limited quantity of residues will actually undergo a stabilization process. Stabilization will occur in cases where characterization has shown it is required to meet Interim Safe Storage Criteria (ISSC) or when characterization will not be performed. This section covers the residues that will be stabilized while the residues section under Safety Issue 2 covers direct repackaging of the remaining residues and removal from the Site of all residues. Table 5.4.3-2 summarizes the crosswalk between current path forward for residues and original 94-1 Implementation Plan.

Plans for high-risk residues requiring stabilization are as follows:

Salts: Selected salts will be stabilized by pyro-oxidation, blended to below the 10 weight percent plutonium concentration limit and repackaged in a pipe overpack component to meet Interim Safe Storage Criteria (ISSC) and WIPP standards.

IDC 414, 365, and 427 salts remain classified as high risk salts (about 1,450 kgs) and will be stabilized by July 1999.

IDC 413, 434, and 654 have been characterized at an 80 percent confidence level. Further characterization of these IDCs will not be performed because some of these salts will be used as a blending source for the high plutonium concentration level salts that will be pyro-oxidized, or because it is more schedule and cost effective to stabilize these salts versus characterizing them due to the small amounts involved.

Wet Combustibles: All leaded gloves have been stabilized. Repackaging wet/combustible residues to meet the ISSC and the WIPP acceptance criteria started on October 6, 1998. Ion exchange resins are classified as high risk due to the fuel and oxidizer in intimate contact concern. These concerns have been mitigated through neutralization and repackaging these materials into polyethylene bottles that are awaiting cementation. Cementation of the ion exchange resins will be completed by March 1999.

Approximately 11,000 kg of wet/combustible residues are classified as high risk. Sampling data at an 80 percent confidence level indicates that this higher risk inventory can simply be repackaged vice processed. Under the assumption that this material will be proven to be low risk through characterization, the existing milestone, “Stabilize higher risk combustibles (11,000 kg) by November 1998,” is deleted. Characterization of the high risk combustibles at the 95 percent level will be completed by February 1999. If any population or sub-population remains classified as high risk, a

Table 5.4.3-2: Crosswalk between current RFETS residue path forward and original DNFSB 94-1 IP

Category	Residue / Quantities / IDCs	Path Forward	Crosswalk from original 94-1 IP
Salts	1. ***Direct Repack Salts*** **15,907 kg** IDCs 363, 364, 365, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 418, 426, 427, 429, 433, 434, 435, 473, and 654	Blend, as required, repack into the pipe component and ship to WIPP (will pyro-oxidize the following IDCs: 365, 413, 414, 427, 434, and 654)	* IDCs 333, 655 and 044 moved to the Ash category * IDC 443, in figure 3.3-2 of the original 94-1 IP is a typo (should have been 433) and does not exist
Ash	2a. ***Ash and Graphite Fines*** **24, 834 kg** IDCs 044, 310, 333, 368, 372, 373, 374, 378, 393, 419, 420, 421, 422, 423, 428, 601, and 655	Size reduce and blend, if necessary, and repack into the pipe component and ship to WIPP (IDC 333 will be stabilized)	* IDC 089 has been moved to Wet/Combustibles category * IDC 312 has been moved to Dry/Repacks category
	2b. ***Sand, Slag and Crucible residues*** **3,034 kg** IDCs 387, 390, 391, 392, 394, 395, 396, and 398	Repack and ship to SRS for Pu recovery	* IDC 393 move to Ash category to reflect shipment to WIPP vs. SRS
Wet/Combustibles	3a. ***Wet/Combustible residues*** **23,061 kg** IDCs 089, 099, 290, 291, 292, 299, 330, 331, 331G, 332, 335, 336, 337, 338, 339, 340, 341, 342, 376, 430, 431, 441, 490, and H61	Treat for nitrate or organic contaminants, if necessary, or otherwise treat, and package for shipment to WIPP (Leaded rubber gloves, IDCs 339 and 341, have already been washed; IX column resins, IDC 430 and 431 have been rinsed and will be cemented for WIPP)	* Combustible and Wet miscellaneous categories have been combined to a single Wet/Combustibles category * IDC 373 has been moved to Ash category * IDCs 301, 485, 486, 489 have been moved to the Dry/Repacks category
	3b. ***Fluoride residues*** **316 kg** IDCs 090, 091,092, 093, and 097	Repack and ship to SRS for Pu recovery	
Dry/Repacks	4. ***Dry/Repack residues*** **39,328 kg** IDCs 197, 300, 301, 303, 312, 320, 321, 334, 360, 370, 371, 377, 438, 440, 442, 479, 480, 484, 485, 486, and 489	Size reduce, declassify, and blend, if necessary, and repack for shipment to WIPP	* IDCs previously categorized as Inorganic
Others	5. ***Other*** **78 kg** IDCs 050 and080	IDC 080 will be packaged in 3013s	* IDC 050 (skulls) have been dispositioned and no longer exist

milestone date to stabilize this material will be established once the quantity and type of hazard is identified.

Ash: Most of the ash residues initially classified as high risk have been re-characterized as low risk (See Safety Issue 2 below). The primary exception is IDC 333 (calcium metal), which will be stabilized by July 1999.

Sand, slag, and crucible (SS&C) residues will be repackaged and sent to the Savannah River Site (SRS) for processing. Shipments of SS&C to SRS will be completed by November 2000. This date is based on the receipt capability and canyon operations at SRS. See section 5.4.2 for when this material will be stabilized.

In all less than six percent of the RFETS residue inventory will undergo a stabilization process.

Metals and Oxides: All plutonium metal items that were not in compliance with the Site storage requirements (i.e., HSP 31.11) have been physically inspected. Originally, 1,858 items were identified as not in compliance; of these 256 items were suspected of being packaged in direct contact with plastic. Each one of these was opened, brushed, and repackaged by November 1995. The remainder of the 1,858 items were brushed and repackaged by May 1997, including an additional 100 items which had been identified also to be suspect during the inspection process. All generated oxide, plus the existing backlog of unstabilized oxide, underwent thermal stabilization. See Safety Issue #2 for the site's plans to package this material in accordance with DOE STD-3013-96.

Safety Issue 2
Within a reasonable amount of time, remaining materials should be stabilized and safely stored before aging causes them to become an imminent health and safety hazard to workers and the public.

Resolution Approach

Residues

Background: A majority of the residues were initially classified as high risk and considered to represent an imminent safety risk to site workers due to a potential for fire, explosion, deflagration, building contamination, plutonium dispersion, and other increased safety risks due to degraded packaging integrity. As a result, initial plans were developed to stabilize this material. Subsequent characterization results indicate that these materials are significantly less hazardous than previously assumed. New plans for the disposal of these residues without the need to first stabilize them have been developed for most of these residues. Direct disposal of these residues is possible if 1) these residues are reclassified from high to low risk based on characterization to the 95/5 confidence level; and 2) a variance is granted to terminate safeguards on these residues.

Characterization Insights
During 1997 and 1998, extensive characterization of the Rocky Flats residues was completed. With the exception of IDC 333, all characterization data at the 80 percent confidence level indicates that a hazard exists in no more than 15 percent of any IDC. To reclassify high risk residues as low risk, additional characterization samples will be obtained to ensure that there is a 95 percent confidence level that a hazard exists in no more than 5 percent of the population ("95/5 confidence level"). The

results of these additional analyses are expected to be consistent with the data acquired to date. DOE expects that the majority of residues will be reclassified as low risk residues and disposed of without stabilization.

Salt residues were initially classified as a high risk residue. Many of the salt residues have been sampled at the “95/5 confidence level” and have shown no hazards and will be disposed of without any stabilization.

Graphite fines were also considered to be high risk; however, characterization has been completed to a “95/5 confidence level” that these materials are low risk. Incinerator ash and related residues with the exception of IDC 368 (MgO crucibles), IDC 333 (calcium metal), and sand, slag, and crucible residues were considered to be medium risk residues. Venting of the drums eliminated the only postulated hazard, accumulation of flammable gases and, therefore, incinerator ash and related residues can be considered low risk. IDC 368 will be sampled at the “95/5 confidence level” and reclassified as a low hazard residue by February 1999. In addition, characterization data at the 80 percent confidence level is complete for incinerator ash and related residues and has confirmed the absence of hazardous properties.

Wet combustible residues were also considered to be a high risk. Initial characterization data is also revealing the once postulated hazards are less than previously assumed. DOE expects that most of the wet combustible residues will be reclassified as low risk residues making stabilization unnecessary.

Upon reclassifying any high risk residues to low risk residues, the basis of reclassifying will be forwarded to the DNFSB. The revised milestones to complete repackaging low risk residues are based on the results at 80/15 confidence level with additional characterization samples required for 95/5 confidence level.

Packaging Residues into a Pipe Component

The pipe overpack component (POC) was developed by RFETS to increase the plutonium loading of the TRUPACT II in order to minimize the amount of drums and shipments to WIPP and to improve storage safety. The POC underwent and passed the Department of Transportation type B shipping container testing at the Sandia National Laboratory and was subsequently certified by the Nuclear Regulatory Commission for use.

Characterization analyses indicate that many of the residues can be classified as low risk even with small quantities of metallic species present. The amount of elemental metals that can be contained within a POC and undergo instantaneous oxidation without compromising the O-ring gasket has been evaluated. The POC has been structurally assessed and the POC’s filter has been physically tested. All candidate IDCs for the POC can be safely contained without consequence.

The POC provides an additional margin of safety with regard to their storage, handling, transportation, and disposal. The DOE response to the Defense Nuclear Facilities Safety Board Recommendation 94-3 required that a strategy be developed to reduce risk to the public and to the worker from highly dispersible residues. The strategy, developed in April 1997, was to place dispersible residues into the POC. The tests conducted at the Sandia National Laboratory and a nuclear safety evaluation concluded that transuranic waste in a pipe component could be excluded from the material at risk associated with a seismic event.

Safeguard Termination Limit Variances

Following dissemination of guidance by the Department of Energy for terminating safeguards on nuclear material, additional processing requirements were identified to either reduce the plutonium content of the residue or to make plutonium recovery more difficult in order to meet these Safeguards Termination Limits (STL). The Rocky Flats Environmental Technology Site requested and received authority to terminate safeguards on all residues below ten weight percent plutonium that are planned to be disposed of at WIPP. With the implementation of additional safeguard controls and through lowering of the plutonium concentration during repackaging, a sufficient level of safeguards protection can be provided for these residues during the transport to and above ground storage at WIPP prior to disposal.

Implementation Plan Schedule Acceleration

Direct repackaging of residues that have been classified as low risk and have had safeguards terminated yields several meaningful benefits: significant cost savings: the ability to accelerate closure of Rocky Flats by reducing residue processing time by two years; reduction in exposure of operating personnel to radioactive and hazardous materials; reduction in worker risk associated with industrial operations; reduction in the risk to the public through accelerated disposition of dispersible material; and the elimination of environmental hazards and emissions. Waste shipments of all repackaged and stabilized residue materials off site used the assumptions in the site's baseline shipping profile. Efficiencies in the demand and allocation of resources and efforts to increase the number of shipments to WIPP are being evaluated to improve the shipping end dates.

Plans for low hazard residues are described in the following paragraphs.

Salts

Low risk salt residues will be blended to below the 10 weight percent plutonium concentration limit and repackaged into containers and placed in a pipe component to meet ISSC and WIPP standards. The salt repackaging activity has been accelerated from July 2001 to July 2000 through characterization, the use of the pipe component, and approval to terminate safeguards. Additionally, the removal and disposal of salts has been accelerated from 2006 to 2003 to support accelerated site closure.

Ash (including graphite fines)

Low risk ash (including graphite fines) will be blended as necessary to be below the 10 percent plutonium concentration limit, then repackaged into containers and placed in pipe component to meet ISSC and WIPP standards. The repackaging of graphite fines and ash residues has been accelerated from May 2002 to December 2000 through characterization, the use of the pipe component, and approval to terminate safeguards. As with salt residues, the removal and disposal has been accelerated from 2006 to 2004 in support of accelerated site closure.

Wet/Combustibles

With the recharacterization of wet combustible residues from high hazard to low hazard (see discussion under safety issue 1), the need to perform any stabilization will be eliminated. Most of these low hazard wet combustible residues need only undergo a combination of sorting, blending, drying, repackaging, headspace gas sampling, and gas generation testing. A small portion of these low hazard residues need only undergo real-time radiography, headspace gas sampling and gas generation testing. Operations that implement this simplified repackaging strategy commenced on October 6, 1998. All of these residues will meet the WIPP standards and most of these residues will meet the ISSC. A very small portion will not initially meet the ISSC (i.e., double metal containment boundaries), but will be made ISSC compliant or shipped to WIPP by May 2002. A high priority will be placed on shipping combustibles to WIPP, especially those that are non-ISSC compliant. In the interim, surveillance monitoring will be performed to ensure safe interim storage. All repackaging and testing activities will be completed by May 2002. Removal and disposal has been accelerated from 2006 to 2004 to support accelerated site closure. Fluoride residues are to be repackaged and shipped to Savannah River. Shipment of these residues to SRS will be complete by September 2000. See section 5.4.2 for when fluoride residues will be stabilized.

Dry/Repack Residues

Dry/repack residues do not require stabilization but must be repackaged to meet the ISSC and WIPP standard. Additional repackaging stations and increased safeguard measurement capabilities will be used to ensure that the repackaging of these materials is completed by May 2002. Removal and disposal has been accelerated from 2006 to 2005 in support of accelerated site closure.

Residues Summary

In light of characterization developments, robustness of the POC, and termination of safeguards on residues, the above modifications to the original Defense Nuclear Facilities Safety Board Recommendation 94-1 Implementation Plan have been made to accelerate residue removal from the Site. Specifically, residues that have been determined or will be determined by characterization to be low risk are not required to be stabilized. Safeguards will be terminated and these residues will be repackaged to meet the WIPP waste acceptance criteria and interim safe storage criteria. The POC will be used for ash and salt residues to prevent dispersion of the residues, and to provide defense in-depth in case of an untoward reaction inside the container. Residues that remain classified as high-risk materials will be stabilized and repackaged for disposal at WIPP or further processing at SRS. For residues that will be shipped off-site for further processing, the material will be stabilized as required to meet shipping requirements. Pending shipment to WIPP, a post-stabilization monitoring program for all residues will be implemented to assure safe interim storage.

Metals and Oxides

In order to meet DOE-STD-3013-96, the long term storage standard, a packaging system with manual furnaces is being installed in Building 371. The system will feature the capability to brush loose oxide from metal, stabilize the oxide to meet the 0.5 percent Loss on Ignition (LOI) requirement, and package both metal and oxide in a welded stainless steel container, which is sealed within a second welded stainless steel container. This system will be available to start packaging metal or oxide into 3013 containers by January 2000.

The Department would accelerate the shipment of plutonium metal and oxides at Rocky Flats to the Savannah River Site (SRS) if DOE decides, following completion of the Surplus Plutonium Disposition EIS, to immobilize this material at SRS. This would support the goal of accelerating closure at Rocky Flats from 2010 to 2006. The K-Area at SRS is being modified to allow storage of Rocky Flats' plutonium pending disposition. Shipments to SRS are planned to begin in January 2000 and complete in December 2002. Classified plutonium will not be packaged in a 3013 container before shipment to SRS. This material will be declassified by SRS then put into a 3013 container.

Scrub alloy, an alloyed button of plutonium and americium from the scrubbing of salts from the molten salt extraction process, will be shipped to SRS for processing in F-Canyon. Processing of the scrub alloy at SRS allows the americium (a high worker exposure source) to be extracted to the high-level waste processing system and the by-product plutonium metal to be packaged to the long-term storage standard. Shipments will be completed by November 1999. See Section 5.4.2 for when this material will be stabilized.

Deliverables/Milestones

Solutions

- ***Commitment Statement:*** Complete draining and processing all B371 liquids.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 371
  Commitment Deliverable: Complete draining and processing all B371 liquids.
  Due Date: June 1999

- ***Commitment Statement:*** Drain six actinide systems in B771.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 771
  Commitment Deliverable: Six actinide systems drained in B771.
  Due Date: September 1999

- ***Commitment Statement:*** Drain eight additional actinide systems in B771.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 771
  Commitment Deliverable: Eight additional actinide systems drained in B771.
  Due Date: September 2000

- ***Commitment Statement:*** Complete removal of all liquids in B771 (including all non-actinide systems).
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 771
  Commitment Deliverable: Remove all liquids from B771.
  Due Date: December 2001

- ***Commitment Statement:*** Complete processing all of the B771 liquids.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 371
  Commitment Deliverable: All B771 liquids processed.
  Due Date: March 2002

Metal and Oxide >50% Plutonium

- ***Commitment Statement:*** Start packaging metal or oxide into 3013 containers.

Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
Applicable Facilities: Building 371
Commitment Deliverable: Start packaging metal or oxide into 3013 containers
Due Date: January 2000

- **Commitment Statement:** Repackage all metal and oxides (except classified metal) into 3013 containers.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 371
  Commitment Deliverable: Repackage all metal and oxides (except classified metal) into 3013 containers.
  Due Date: May 2002

Residues <50% Plutonium

- **Commitment Statement:** Complete characterization of specified salt, combustible, and IDC 368 residues to a 95/5 confidence level.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 371, 707, 776/777, and 559
  Commitment Deliverable: Complete characterization of specified salt, combustible, and IDC 368 residues to a 95/5 confidence level.
  Due Date: February 1999

- **Commitment Statement:** Complete stabilizing ion exchange resins.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 771 and 774
  Commitment Deliverable: Complete stabilizing ion exchange resins.
  Due Date: March 1999

- **Commitment Statement:** Stabilize high risk salts.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 707 and 371
  Commitment Deliverable: Stabilize high risk salts.
  Due Date: July 1999

- **Commitment Statement:** Stabilize ash residue IDC 333.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 707, 559, and 371
  Commitment Deliverable: Stabilize ash residue IDC 333.
  Due Date: July 1999

- ***Commitment Statement:*** Complete repackaging of all salts.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 707 and 371
  Commitment Deliverable: Complete repackaging of all salts.
  Due Date: July 2000

- ***Commitment Statement:*** Complete shipping fluorides to SRS.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 371
  Commitment Deliverable: Complete shipping fluorides to SRS.
  Due Date: September 2000

- ***Commitment Statement:*** Complete shipping SS&C to SRS.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 707 and 371
  Commitment Deliverable: Complete shipping SS&C to SRS.
  Due Date: November 2000

- ***Commitment Statement:*** Complete repackaging ash.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 707 and 371
  Commitment Deliverable: Complete repackaging ash.
  Due Date: December 2000

- ***Commitment Statement:*** Complete repackaging dry/repack residues.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Buildings 707, 371, and 776/777
  Commitment Deliverable: Complete repackaging dry/repack residues.
  Due Date: May 2002

- ***Commitment Statement:*** Complete repackaging wet/combustibles.
  Responsible Manager: Henry F. Dalton, DOE-RFFO, Assistant Manager
  Applicable Facilities: Building 371
  Commitment Deliverable: Complete repackaging wet combustibles.
  Due Date: May 2002

5.4.4 Oak Ridge

Safety Issue 1

Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.

Resolution Approach

Deposit Removal Project at the East Tennessee Technology Park (ETTP). All of Oak Ridge's Deposit Removal Project Recommendation 94-1 Implementation Plan commitments have been completed. The original materials at the ETTP that fell under Safety Issue 1 were 65 deposits of HEU in the systems in the K-25 Building which were greater than 500 grams each and may have presented an unacceptable criticality risk. Knowledge gained during completion of mechanical removal of four of the deposits in March 1996 and additional criticality safety analyses caused the scope of the project to be reassessed. All but nine of the 61 deposits remaining were determined to be in stable configurations that satisfied the double contingency principle for criticality safety and, therefore, did not require near-term removal. Additionally, three deposits in the K-29 Building were judged to be of sufficient concern that they were added to the project.

As a result of the reassessment of the K-25 deposits and the addition of the K-29 deposits, Oak Ridge submitted a proposed change to the Recommendation 94-1 Implementation Plan in July 1997. The change, which was approved by the Secretary in October 1997 and subsequently accepted by the DNFSB, revised the site's 94-1 Deposit Removal commitments into two categories. Category 1 deposits, defined as deposits having one control on a single nuclear parameter, were removed by early December 1997 completing that commitment on time. The Category 2 deposits (those having multiple controls on a single nuclear parameter) were physically removed by January 29, 1998, thus completing the commitment two months early.

Safety Issue 2

Within a reasonable amount of time, remaining materials should be stabilized and safely stored before aging causes them to become an imminent health and safety hazard to workers and the public.

Resolution Approach

The remaining materials at Oak Ridge not covered under Safety Issue 1 above are plutonium stored at ORNL in Building 3027 and uranium salt in the Molten Salt Reactor Experiment. Plans to complete stabilization of these materials are described in the following paragraphs.

Plutonium: The quantities of plutonium metals and oxides (>50% assay) and plutonium residues and mixed oxides (<50% assay) shown in Tables 3.2-1, 3.2-2, and 3.3-1 of the original Recommendation 94-1 Implementation Plan (March 1995) erroneously include both materials that continue to have a programmatic use and materials that are excess to programmatic needs. Only the excess materials, approximately 609 grams of Pu-238/Np-237 designated for transfer to the Department's Pu-238 Heat Source Program and approximately 708 grams of "other" plutonium identified as unneeded and packaged awaiting shipment to LLNL, are specifically 94-1 materials.

It is Oak Ridge's intention that it will meet its one 94-1 plutonium commitment to, "Repackage all plutonium metals and oxides to meet the metal and oxides storage standard," by May 2002, by transferring the Pu-238/Np-237 to the Department's Pu-238 Heat Source Program when facilities are available to secure the material, and by shipping its other 94-1 material to LLNL where it will be integrated into and processed with that site's 94-1 Plutoniuminventory. An agreement for shipping the material in FY 1999 is currently being negotiated with LLNL.

Molten Salt Reactor Experiment (MSRE). The Molten Salt Reactor operated from 1965 through 1969 to investigate molten salt reactors for commercial power applications. The reactor fuel, uranium tetrafluoride, was a constituent in a molten salt mixture including lithium, beryllium, and zirconium fluorides that circulated through the reactor primary system. Initially the reactor was fueled with U-235, which was replaced with U-233 in 1968. Less than 1 kg of plutonium tri-fluoride was added in 1969. When the reactor was shutdown, the fuel salt was drained into two fuel drain tanks in the drain tank cell, where it cooled and solidified. The reactor core was partially cleaned by circulating a molten flush salt through the system, which was then drained into a flush tank for storage. Following a post-operation examination, the facility was placed in a surveillance and maintenance program to await eventual decommissioning. Radiolysis of the fuel salt was expected to slowly produce fluorine (F_2) gas. A procedure to annually heat the salt without melting was begun to recombine the F_2 into the salt.

In the late 1980s, radiological surveillance at the facility indicated elevated radiation in piping connected to the drain tanks. A visible release of an unidentified gas was also observed from the off-gas system piping during a maintenance action. Migration of stored fuel was suspected and an investigation was initiated. Gas samples taken in 1994 indicated significant concentrations of uranium hexa-fluoride (UF_6) and F_2. A significant solid deposit of uranium was also detected in the inlet section of a charcoal filter in the off-gas system. This filter, the Auxiliary Charcoal Bed (ACB) was located under water in a concrete cell outside the reactor building. If water were to have entered the ACB and migrated to the deposit, the potential for accidental criticality could not have been eliminated. In addition, the exposure of the activated charcoal in the bed to both F_2 and UF_6 was postulated, and later confirmed in laboratory testing, to have created a potentially explosive compound mixed with the uranium deposit.

A comprehensive plan was developed in 1994 to implement interim corrective measures to mitigate the criticality potential, stop continued uranium migration to the charcoal bed, and enhance the containment of the charcoal bed cell to prevent radionuclide releases from a potential explosion. These measures were completed in November 1995. During these first remediation actions, uranium migration into fuel processing equipment was discovered in additional cells at the facility. In early 1996 during preparations for removal of the UF_6 and F_2, off-gas system pressures near the drain tanks were measured at 10 psig and several internal plugs in the piping system were discovered. A chemical trapping system to depressurize the off-gas system and remove the UF_6 and F_2 started operation in November 1996. Initial operation removed small amounts of UF_6 and F_2, and non-volatile blockages were confirmed.

The new information on the extent of uranium migration and blockages in the MSRE piping lead to an expansion of the scope of the original program and development of a revised plan for remediation. The revised plan was included in the Implementation Plan change approved by the Secretary and accepted by the DNFSB in late 1997.

Concentration of gaseous UF_6 in the fuel and flush tank void spaces and the off-gas piping has been reduced to less than one percent by dilution purges and ClF_3 treatments. Chemical denaturing of the charcoal bed to eliminate the explosive potential of the fluorinated charcoal was completed in March 1998. By August 1998, 22.3 kg of uranium in the form of UF_6 had been extracted with the gas removal equipment. Charcoal bed uranium deposit removal will be completed by February 1999. Since the removal of fuel and flush salts is a Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA) Interim Remedial Action, a Feasibility Study, proposed plan, and Record of Decision for the disposition of the fuel salt and the reactor flush salt were submitted to and approved by the State of Tennessee Department of Environment and Conservation, and the Environmental Protection Agency. The site's MSRE 94-1 commitment will be completed when the fuel and flush salt are removed by May 2002 in accordance with the approved CERCLA Record of Decision.

Deliverables/Milestones

Metal and Oxide >50% Plutonium

- ***Commitment Statement:*** Repackage all plutonium metals and oxides to meet the metal and oxide storage standard.
  Responsible Manager: H. Clark
  Applicable Facilities: ORNL, Building 3027
  Commitment Deliverable: Dispose of unneeded plutoniumat ORNL.
  Due Date: May 2002

Uranium

- ***Commitment Statement:*** Remove uranium deposit from Auxiliary Charcoal Bed.
  Responsible Manager: M. Jugan
  Applicable Facilities: ORNL, Building 7503
  Commitment Deliverable: Remove uranium deposit from Auxiliary Charcoal Bed Cell.
  Due Date: February 1999

- ***Commitment Statement:*** Complete fuel and flush salt removal from MSRE.
  Responsible Manager: M. Jugan
  Applicable Facilities: ORNL, Building 7503
  Commitment Deliverable: Remove fuel salt and flush salt from fuel drain tanks and flush tank.
  Due Date: May 2002

5.4.5 Los Alamos National Laboratory

Safety Issue 1
Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.

Materials in the original 94-1 inventory at Los Alamos National Laboratory (LANL) included several high-risk residue material categories (sand, slag and crucible, hydroxide precipitates, silica filter residues, and cellulose clean-up rags). Potential worker-safety concerns surrounding these materials have been mitigated by chemical stabilization or surveillance activities.

Safety Issue 2
Within a reasonable amount of time, remaining materials should be stabilized and safely stored before aging causes them to become an imminent health and safety hazard to workers and the public.

Resolution Approach

The remaining materials at LANL fell under Safety Issue 2. Plans to complete stabilization of these materials are described in the following paragraphs.

<u>Plutonium Metals and Oxides:</u> Based on changing mission requirements for materials at the LANL, the requirement to package all plutonium metal and oxide to a long-term storage configuration is no longer being applied to material at LANL. This decision was discussed with the Defense Nuclear Facilities Safety Board in April 1998.

Los Alamos National Laboratory will continue to prepare weapons-grade plutonium metal for temporary storage in a fashion that will continue to address the potential worker-safety issues of improper packaging while still making the metal available for programmatic use if required. The items will be inspected, the oxide separated from the metal, and the metal will be encapsulated. In all cases, the temporary storage system adopted for weapons-grade plutonium metal will meet or exceed the safety requirements currently in effect (by written operating procedure) for existing packaging systems used for storage of materials in the TA-55 vault. To accommodate this change in end-state requested by DOE, the metal items will be packaged according to the following graded criteria:

- LANL plans to use a full DOE-STD-3013-96 package to store strategic reserve weapons-grade metal and oxide, excess weapons-grade metal and oxide, and non weapons-grade metal and oxide. Currently, LANL has generated about 100 packages meeting the DOE-STD-3013-94 criteria. Since the majority of this material is not currently assessed as excess to programmatic needs, nor is it destined for transfer to another site, LANL has no plans to repackage these items to meet DOE-STD-3013-96.

- To preserve the metallic state of metal feed for pyrochemical purification and manufacturing, LANL will temporarily store metal for programmatic use in reusable flanged containers with disposable knife-edge gaskets (ConFlat containers).

Preparing plutonium oxide for temporary storage consists of collecting the oxide from the burning of plutonium metal; from the separation of oxide during inspection, consolidation, and brushing of plutonium metal items; or from the recovery of plutonium as oxide from residue sources. Thermal stabilization will be performed on the oxide to assure complete oxidation of occluded metal fines if the source of the oxide is metal. Stabilized oxide will not be encapsulated for temporary storage as planned for the metal, but will be packaged in a system acceptable, by written procedure, for storage in the LANL vault. The current LANL vault packaging configuration consists of a stainless steel slip-lid material container (or equivalent) enclosed in a bagout bag, and finally contained in a stainless steel slip-lid secondary container (or equivalent). Vault personnel have stopped allowing galvanized or tin-plated mild steel cans for routine use as any container, and have successfully developed and procured reusable stainless steel containers that have threaded closures equipped with radionuclide filter vents. LANL is currently integrating this new packaging system into routine use for temporary storage of nuclear material.

In the event plutonium metal or oxide packaged in a temporary storage system is determined to be excess to programmatic needs, it will be packaged for long-term storage according to DOE-STD-3013.

Residues: With this revision, the original May 1994 legacy Los Alamos National Laboratory (LANL) residue inventory subject to stabilization and repackaging to meet the DOE-STD-3013 long-term storage criteria has been corrected to remove inaccuracies in the original Implementation Plan text. The corrected total for the LANL inventories of <50% assay plutonium residues is presented in Table 5.4.5-1. In addition, Table 5.4.5-2 shows the residue inventory remaining as of October 1, 1998. Included for completeness are the remaining pure metal and oxide inventories as well.

LANL operates a full suite of aqueous nitrate and aqueous chloride processes for plutonium separation and recovery from residue sources; as well as inspection, consolidation, and stabilization activities for small nuclear material items prior to aqueous recovery. With this aqueous processing capability, LANL intends to separate and recover plutonium as oxide from its associated matrix and package the oxide in a temporary packaging system for use in other DOE programs or for final packaging to meet the long-term storage standard.

For the past four years, establishing the stabilization queue for the various residue categories listed in Tables 5.4.5-1 and 5.4.5-2 was accomplished by assigning process capacity to the *high-risk* categories first and then matching any excess processing capacity with the various material subsets under the high-priority categories. Also taken into consideration was the need to separate nitrate feed from chloride feed (no chloride feed to nitrate operations). This approach was continuously validated and modified by using annual vault sampling and item inspection data to form a risk-based prioritization methodology. This approach continuously allows LANL to assess their inventory and adjust prioritization to minimize worker-safety risk or risk perceptions. Examples of its benefit include identification of two *high-risk* categories previously unrecognized (cellulose cleanup rags and silica filter residues) as well as identifying inadequate packaging surrounding the entire category of analytical chemistry sample returns.

Now that the Los Alamos *high-risk* milestone, *Stabilize high-risk vault items and recover the plutonium as oxide,* has been completed, processing capacity will be assigned to high-priority material categories (or subsets) and will continue to be validated by vault sampling data, vault inspection data, and item inspection data. Reports detailing the results of inspection and surveillance data have been prepared and will continue to be prepared describing the methodology, any changes made to the methodology, and the impacts of data analysis on stabilization priorities.

Table 5.4.5-1: LANL Adjusted May 1994 Legacy Inventory of <50% Assay Plutonium Residues*

Residue Inventory	Plutonium Content (kg)	Number of Items
High-Risk SS&C	38	307
High-Risk Hydroxide Precipitate	22	313
High-Risk Silica Solids	4	52
High-Risk Cellulose Rags	2	113
Impure Metal	89	1448
High Priority Process Residues	106	582
Analytical Chemistry Sample Returns	7	194
Analytical Chemistry Solution Returns	4	480
High Priority Compounds	15	126
Other Combustibles	<1	72
Other Compounds	95	1540
Other Process Residues	350	1222
Non-combustible Items	62	864
Unsheltered Containers	21	13
Gases	<1	1
Total	815	7327

*Neptunium, americium isotopes, plutonium contaminated uranium isotopes, ^{233}uranium, and other non-plutonium transuranic materials are included in the item inventory, but their SNM value is not included in the plutonium total.

Prior to plutonium separation and recovery, plans are to evaluate each material category under the safeguards termination limits (STL) considering the criteria described in the plutonium disposition methodology (PDM). The anticipated outcome of this evaluation for each material category will be one of three possible disposition paths depending on the plutonium concentration and distribution within the material category: disposition as transuranic waste if the plutonium concentration is below the STL value for the matrix of interest; aqueous processing for plutonium separation and recovery if the plutonium concentration is above a certain value determined by the PDM; and immobilization in either cement or glass if the plutonium concentration is above the STL value but below the aqueous recovery value determined by the PDM.

Table 5.4.5-2: Stabilization Schedule for Remaining LANL May 1994 Legacy 94-1 Inventory of Pure Plutonium Metal, Oxide, and the <50% Assay Plutonium Residues (estimates as of October 1, 1998)

Legacy Plutonium Inventory (Items Only)	**FY95†**	**FY96†**	**FY97†**	**FY98†**	**FY99**	**FY00**	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**	**Totals**
Pure Plutonium Metal	**84**	**210**	**169**	**24**	65	60						**612**
Pure Plutonium Oxide	**0**	**0**	**0**	**0**		8	40	40	20			**108**
High-Risk SS&C	**146**	**36**	**99**	**26**								**307**
High-Risk Hydroxide Precipitate	**148**	**37**	**82**	**10**	36*							**313**
High-Risk Silica Solids (added 7/96)	**7**	**12**	**18**	**7**	8*							**52**
High-Risk Cellulose Rags (added 7/96)	**44**	**2**	**44**	**20**	3*							**113**
Impure Metal	**281**	**327**	**96**	**54**		130	140	140	140	140		**1448**
High Priority Process Residues	**29**	**26**	**21**	**44**		45	50	62	100	125	80	**582**
Analytical Chemistry Sample Returns	**0**	**77**	**51**	**0**	32	34						**194**
Analytical Chemistry Solution Returns	**386**	**45**	**14**	**17**	18							**480**
High Priority Compounds	**19**	**24**	**0**	**0**	47	36						**126**
Other Combustibles	**28**	**24**	**6**	**14**								**72**
Other Compounds and *Impure Oxide***	**260**	**89**	**304**	**8**	85	150	250	250	250	250	208	**2104**
Other Process Residues	**111**	**80**	**86**	**18**	45	100	150	160	160	157	155	**1222**
Non-Combustibles	**175**	**81**	**70**	**5**	50	60	60	100	100	100	63	**864**
Unsheltered Containers	**1**	**1**	**1**	**0**	1	1	1	1	2	2	2	**13**
Gases	**1**											**1**
Totals	**1720**	**1071**	**1061**	**247**	**390**	**624**	**691**	**753**	**772**	**774**	**508**	**8611**

* The status, composition, and approach for addressing these items is being discussed separately.

**Impure oxide requiring purification prior to programmatic use has been included in this category.

† Actual quantities stabilized.

Los Alamos intends to utilize the *Criteria for Interim Storage of Plutonium-Bearing Materials* only for the storage of plutonium-contaminated actinide oxide or metal with plutonium assay values <50 percent. Treatment and packaging of these materials will essentially follow the DOE-STD-3013 criteria for long-term storage, but because of the plutonium assay value (<50 percent), the Interim Storage Criteria will be the storage guidance document.

The remainder of the legacy inventory as presented in Table 5.4.5-2 is scheduled to be stabilized by the end of FY 2005. Los Alamos has completed the original *high-risk* Implementation Plan Milestone, *Stabilize high-risk vault items and recover the plutonium as oxide*, (originally due September 1997), for Pu-239 and mixed-actinide items. The remaining high-risk inventory described in Table 5.4.5-2 is the Laboratory-wide inventory and includes uranium residues, approved designated waste, Pu-238 residues, and Pu-242 residues. Capability to stabilize Pu-238, Pu-242, and HEU residues is currently not available to meet the projected September 1998 schedule. In anticipation of this, the Pu-242 items have been inspected as part of the Los Alamos annual vault surveillance program, or are physically located in glovebox enclosures (thereby mitigating worker-safety concerns) and are scheduled for plutonium recovery within the next calendar year.

Los Alamos is currently developing and installing a small aqueous Pu-238 recovery sequence for oxide and residue processing. Current schedules indicate it will be not be available for routine residue recovery operations for at least a few years. In the meantime, the inventory of high-risk Pu-238 residues consists of eight hydroxide cakes and two cellulose rags, which will be inspected annually as part of the vault surveillance and inspection program and repackaged if necessary. Regarding the HEU residues , it is inappropriate to apply the same risk designation to these residues and compare them to plutonium. These residues will be stabilized as appropriate when the ULISSES line is commissioned within the next several years. Current status of the remaining *high-risk* inventory is listed below:

Sand, Slag, and Crucible (SS&C): Totally stabilized by aqueous processing.

Hydroxide Precipitates: The remainder of this material category contains Pu-242 and Pu-238 and will not be processed in equipment dedicated for Pu-239 processing. LANL is actively restarting the Pu-242 process sequence. Once certain process modifications are completed and analytical chemistry techniques are certified for use, LANL will begin plutonium recovery operations (stabilization). Five of the 29 Pu-242 contaminated hydroxide cakes are located in the TA-55 vault and were inspected during the FY 1997 vault inspection program. The remaining Pu-242 hydroxide cakes are located in glovebox enclosures where the worker-safety risk from these items is mitigated. Similarly, none of the eight remaining hydroxide precipitates contaminated with Pu-238 are located in the vault.

Silica Solids: The non-Pu-242 items were stabilized by chemical processing in April 1998. Of the six remaining Pu-242 items, five are located in glovebox enclosures awaiting the restart of the processing line. The single remaining item in the vault will be inspected and introduced for processing.

Cellulose Cleanup Rags: There exist two cellulose items contaminated with Pu-238 and one item contaminated with HEU. These items will be stabilized and the actinide recovered when actinide-specific recovery capacity is established.

It must be emphasized that the schedule for items in Table 5.4.5-2 does not include the stabilization of newly generated residues (items with a creation date after May 1994) and only presents the anticipated stabilization schedule for the remaining legacy inventory. The integrated response to plutonium residue stabilization and scrap recovery at Los Alamos incorporates the two inventories and anticipates parallel approaches to achieve stabilization of both inventories—the legacy inventory in 2005, and by 2011 to achieve an inventory of around 2,000 items in the TA-55 vault with no item older than about three years.

Deliverables/Milestones

Metal and Oxide >50% Plutonium

- ***Commitment Statement:*** All legacy[3] metal and oxide will be inspected and repackaged. Material designated for DOE programmatic activities will be packaged to meet Los Alamos temporary storage criteria. Other material will be packaged to meet the long-term storage standard.

  Responsible Manager: Jon MacLaren, DP-24
  Applicable Facilities: TA-55, CMR
  Commitment Deliverable: All legacy metal and oxide stabilized.
  Due Date: September 2003

Residues <50% Plutonium

- ***Commitment Statement:*** All legacy residues will be stabilized and the plutonium recovered as oxide. Material designated for DOE programmatic activities will be packaged to meet Los Alamos temporary storage criteria. Other oxide will be packaged to meet the long-term storage standard.

  Responsible Manager: Jon MacLaren, DP-24
  Applicable Facilities: TA-55, CMR
  Commitment Deliverable: All legacy residues stabilized.
  Due Date: September 2005

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[3] Legacy materials are those with a creation date before May 1994.

5.4.6 Lawrence Livermore National Laboratory

Safety Issue 1
Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.

No material category at Lawrence Livermore National Laboratory (LLNL) fits the Safety Issue 1 criteria.

Safety Issue 2
Within a reasonable amount of time, remaining materials should be stabilized and safely stored before aging causes them to become an imminent health and safety hazard to workers and the public.

Material categories which fall under the Safety Issue 2 grouping are 114 cans of ash residues, 91 containers of metal that are either double canned or that use aluminum foil as the inner barrier, and 92 containers of other plutonium oxides greater than 50 wt% plutonium. This inventory is located in Building 332, which is a functional plutonium processing and handling facility that meets federal, state, and local environmental regulations as outlined in the LLNL Environmental Impact Statement.

Resolution Approach

LLNL is procuring the Plutonium Stabilization and Packaging System (PuSAP) with which it will process and package its excess 94-1 plutonium inventory to meet the requirements of the plutonium packaging and storage standard (DOE-STD-3013-96). The PuSAP Installation is scheduled to be completed and be operational in the spring of 1999. Processing and repackaging of the 94-1 inventory will begin directly thereafter. In the interim an ongoing packaging characterization and non-destructive assay program will be completed in April 1999.

Ash residues: In 1994, eight of the cans containing ash residues were found to be pressurized. All 114 cans were vented to mitigate the pressurization problem and a study to determine a plan for the stabilization and packaging of the contents for long-term storage was completed. The ash will be washed with water or a weak acid solution and then thermally stabilized in calcination furnace prior to packaging. Ash stabilization and packaging will be completed by May 2000. The resultant material that meets the disposal criteria will shipped to WIPP. The remainder will be retained on site until a decision for further disposition is made.

Metal and Oxide Materials: LLNL has approximately 91 containers of metal and 92 containers of oxide that are excess inventory not required to support active Defense Programs missions. This material will be thermally stabilized and packaged in accordance with DOE-STD-3013 by May 2002. It will be retained in storage on site until further disposition is directed.

Additionally, LLNL is negotiating an agreement with Oak Ridge for that site’s small inventory of plutonium metal and oxide, approximately 708 grams, to be shipped to LLNL during FY 1999 shortly after operations in Building 332 are resumed. The plan is for the material to be integrated into LLNL’s excess metal and oxide inventory and then stabilized and packaged as part of the site’s 94-1 commitment.

<u>Residue materials</u>: A study of the residues other than ash must be completed to determine the appropriate stabilization method. The decision about which stabilization method to use will be made following its completion in FY 2000. The stabilization and packaging of these residues will begin immediately upon completion of the ash residue processing and will be completed in February 2001. The residues that meet the acceptance criteria will be shipped to WIPP. The remainder will remain on site awaiting a decision for further disposition.

Deliverables/Milestones

<u>Metal and Oxide >50% Plutonium</u>

- ***Commitment Statement:*** Complete plutonium metal and oxide repackaging.
  Responsible Manager: Brent Ives, LLNL
  Applicable Facilities: LLNL Building 332
  Commitment Deliverable: Complete plutonium metal and oxide repackaging.
  Due Date: May 2002

<u>Residue <50% Plutonium</u>

- ***Commitment Statement:*** Stabilize and package LLNL's ash residues.
  Responsible Manager: Brent Ives, LLNL
  Applicable Facilities: LLNL Building 332
  Commitment Deliverable: Complete ash stabilization and packaging.
  Due Date: May 2000

- ***Commitment Statement:*** Stabilize and package all other LLNL residues.
  Responsible Manager: Brent Ives, LLNL
  Applicable Facilities: LLNL Building 332
  Commitment Deliverable: Complete all residue stabilization and repackaging.
  Due Date: February 2001

Safety Issue 1

Within two to three years, the interim configuration of some materials stored in the nuclear weapons manufacturing pipeline could pose imminent health and safety hazards to workers and to the public.

Continued wet storage of spent nuclear fuel poses a safety hazard at the Idaho National Engineering and Environmental Laboratory (INEEL). The CPP-603 Fuel Storage Facility is an underwater fuel storage facility that was built in two phases (1951 and 1959) for storage of metal-clad spent nuclear fuel elements pending reprocessing. It consists of three unlined concrete storage basins, two cask handling areas, a fuel element cutting facility, a structural steel/transite superstructure, and assorted basin water treatment areas that were added individually in the 1960s and 1970s. The two basins built in 1951 used a monorail and yoke storage system for fuel storage, and the basin built in 1959 used an open basin filled with free-standing underwater storage racks. The total volume of the three basins is approximately 1.5 million gallons. In 1994, there were 1,141 units of spent fuel stored in the facility comprised of 2.7 t of heavy metal. This fuel was predominantly zirconium-, aluminum-, and stainless steel-clad, and some fuels has been canned because of cladding breaches or for fuel handling economy.

Resolution Approach

The overall approach to reducing the health and safety hazard described above is to move the spent nuclear fuel from CPP-603 and ultimately into dry storage. Until that can be accomplished, several risk mitigation actions have been taken. Installation of accurate level-monitoring instrumentation for the basin water and an accurate basin water balance program has been completed to partially compensate for the absence of leak detection systems. Several actions were completed by December 1994 to improve criticality safety, including storage yoke re-rigging, repackaging of some corroded canisters and spent fuel with deteriorated cladding, and fuel spacing. Complete underwater video inspections of all spent fuel and storage equipment have been completed. The EBR-II uranium metal fuels, which also contain metallic sodium for bonding, are canned because they are potentially reactive with water. The video inspections showed the potential for water inleakage in a few of the EBR-II fuel cans, and subsequent underwater ultrasonic examinations of those cans confirmed the presence of water and potential spent fuel deterioration. The identified cans of EBR-II fuel with water inleakage were removed from the South basin and transferred to the Argonne National Laboratory-West facility in January 1998 for examination and assessment of the deterioration process. The remaining EBR-II cans will be individually ultrasonically inspected for water inleakage before they are removed from the South basin.

Corrective actions taken to address corrosion include storage yoke re-rigging, fuel repackaging, and full implementation of a corrosion monitoring program. Structural analyses have determined the storage basins will meet the design basis seismic events, and corrective actions to resolve non-compliances related to the steel superstructure have been completed.

A federal court order specifies a schedule for fuel movement from CPP-603. The schedule includes 189 fuel units moved by September 1994, an additional 189 units moved by December 1995, all fuel moved from the North and Middle basins by December 1996, and all remaining fuel removed by December 2000. All fuel was to be moved to the CPP-666 wet storage facility in available transport casks unless an agreement was made with the State of Idaho to store specific fuel types in appropriate dry storage areas. To date, the first 189 units were expedited to complete movement by July 1994, the second 189 units were moved by August 1995, and all fuel was moved from the North and Middle basins by August 1996.

An Agreement with the State of Idaho has been obtained to allow movement of the aluminum-clad spent fuel to the Irradiated Fuel Storage Facility (IFSF) dry storage area, some of which will be processed through the dry overpacking station in the IFSF fuel handling cell. Agreement with the State of Idaho has also been obtained to move the EBR-II inventory currently in the South basin to the IFSF dry storage area even though it will not be processed through the dry overpacking station. This agreement was sought because of the detailed inspections of the EBR-II inventory completed in 1994 which showed that water inleakage into a few of the storage containers had occurred, which resulted in deterioration of the fuel. Movement of the EBR-II inventory to dry storage will eliminate the potential for future fuel deterioration, which could result from wet storage.

The dry overpacking station was installed and accepted for operation in July 1997. A structural reinforcement of the IFSF facility was determined to be necessary in FY 1996, and this project was completed in December 1997. State approval to use the IFSF after completion of the structural modification was received in January 1998. Fuel movements from the South basin commenced in May 1995, and well over half (514/744) of the fuel units were moved either to CPP-666 or through the dry overpacking station into the IFSF as of August 18, 1998. The remaining fuel inventory is scheduled to be removed from the South basin well ahead of the court ordered December 2000 completion date.

Deliverables/Milestones

Spent Nuclear Fuel

- ***Commitment Statement:*** Complete Fuel Removal from the CPP-603 South Basin.
  Responsible Manager: Peter Dirkmaat, DOE-ID
  Applicable Facilities: CPP-603
  Commitment Deliverable: All fuel removed from CPP-603 South Basin.
  Due Date: December 2000

6.0 Organization and Management

Completing the commitments identified in this Implementation Plan (IP) is one of the highest priorities of the Department. The Assistant Secretary for Environmental Management (EM-1) is the lead Program Secretarial Official (PSO) for the Department since most of the nuclear materials stabilization activities are under his purview. The Responsible Manager (RM) is the Deputy Assistant Secretary for Nuclear Material and Facility Stabilization, who has authority to perform all associated planning, response, and implementation activities, consistent with guidance provided in the *Manual for Department of Energy Interface with the Defense Nuclear Facilities Safety Board* (DOE M 140.1-1A), Section I.3.f, "Responsibilities of the Responsible Manager." He is also responsible for working directly with program offices and providing recommendations for integration of implementation activities across programs and sites. In fulfilling these duties, he has the authority to escalate plan revision and implementation matters to the appropriate level of management for resolution. The Nuclear Materials Stewardship Program Office (EM-66) is the Recommendation 94-1 Implementation Plan Manager (IPM). The Responsible Manager and the Implementation Plan Manager will work with appropriate managers from the Offices of Defense Programs (DP) and Environmental Management (EM) to ensure that stabilization activities at DP and EM sites are completed in a safe and timely manner.

Program direction shall pass from appropriate Program Offices in EM and DP to Field Offices under their cognizance. Consistent with the Department's Integrated Safety Management policy, the Program and Field Offices have the authority to direct, and are accountable to perform, the nuclear materials stabilization activities safely and in accordance with the Secretarial commitments contained in this IP. They are also responsible to provide timely information so that the Responsible Manager and Implementation Plan Manager can have a realistic assessment of progress toward meeting these commitments.

The Implementation Plan Manager is the day-to-day manager for the 94-1 IP, and shall report directly to the Responsible Manager on 94-1 issues. The Responsible Manager is supported by a 94-1 Management Team, consisting of representatives from each of the Program Offices at Headquarters that have 94-1 related stabilization activities at Field locations under their cognizance. The Offices of Materials Disposition (MD); Environment, Safety and Health (EH); Departmental Representative to the Board; and EM's Office of Science and Technology will also be represented on the 94-1 Management Team. Their participation will ensure proper management of the interfaces between the materials stabilization and disposition programs, adequate resolution of environmental, safety and health vulnerabilities, and timely consideration of technology needs.

Field Office Managers are responsible for developing and executing fully resource-loaded 94-1 management plans for their sites. These plans shall include appropriate narrative and schedules sufficient to indicate how their respective sites will meet their 94-1 commitments. Recommendation 94-1 Site Management Plans (94-1 SMPs) may be developed as independent documents, or they may be identifiable components of each site's current EM Project Baseline Summaries (PBS) as long as the site's program for meeting their Recommendation 94-1 Implementation Plan commitments are readily recognizable and extractible for review.

Reporting

The commitments in this 94-1 IP will be supported by resource-loaded schedules. The resource-loaded schedules for RFETS, Hanford (K-Basin), ORNL, LANL, and INEEL have been accepted by the 94-1 Responsible Manager. The resource-loaded schedules for SRS, Hanford PFP, and LLNL will be developed by April 1999. The available site-level resource-loaded schedules have been integrated into a master schedule for tracking status by the 94-1 Responsible Manager and Implementation Plan Manager. The remaining three resource-loaded schedules will be integrated into the 94-1 master schedule after acceptance by the 94-1 Responsible Manager.

Overall progress toward meeting Recommendation 94-1 Implementation Plan commitments will be reported monthly by each site via direct data inputs into the Department's Safety Issues Management System (SIMS) which is administered by the Office of the Departmental Representative to the Defense Nuclear Facilities Safety Board (S-3.1). Sufficient lower-level milestones have been identified in the master schedule to ensure early warning of potential problems in meeting any Secretarial commitments made in this IP. The 94-1 Management Team will analyze the 94-1 SIMS information each month and review the status of implementation with the Responsible Manager. The 94-1 commitment status will be reviewed with the lead Program Secretarial Official (EM-1), Responsible Manager (EM-60), EM Deputy Assistant Secretaries, and Field Managers on a quarterly basis through a process being institutionalized as a part of the EM Integrated Planning, Accountability and Budgeting System (IPABS). The 94-1 Management Team will work with the appropriate Field Office managers to prepare an annual 94-1 Implementation Plan Status Report using information from SIMS and IPABS. This status report will be an integral part of the Secretary’s Annual Report to Congress.

Change Control

Complex, long-range plans require sufficient flexibility to accommodate changes in commitments, actions, or completion dates that may be necessary due to additional information, improvements, or changes in baseline assumptions. The Department’s policy is to (1) have the Secretary approve all revisions to the scope and schedule of plan commitments; (2) provide prior, written notification to the Board on the status of any implementation plan commitment that will not be completed by the planned milestone date; and (3) clearly identify and describe the revisions and bases for the revisions. Fundamental changes to the plan’s strategy, scope, or schedule will be provided to the Board through formal reissuance of the implementation plan. Other changes to the scope or schedule of planned commitments will be formally submitted in appropriate correspondence approved by the Secretary, along with the basis for the changes and appropriate corrective actions.

Appendices

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Appendix A
Glossary

Actinide—Any of a series of chemically similar, mostly synthetic, radioactive elements with atomic numbers ranging from actinium (89) through lawrencium (103).

Alpha emitter—A radioactive substance that decays by releasing an alpha particle.

Alpha particle—A particle consisting of two protons and two neutrons, given off by the decay of many elements, including uranium, plutonium, and radon. Alpha particles cannot penetrate a sheet of paper. However, alpha emitting isotopes in the body can be very damaging.

Americium—A manmade element. Americium is a metal that is slightly heavier than lead. Americium-241 is produced by the radioactive decay of plutonium-241; in addition to being an alpha-emitter, it is an emitter of gamma rays. Americium-241 has a half-life of 433 years.

As low as reasonably achievable (ALARA)—The approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit, but a process that has the objective of attaining doses as far below the applicable limits as is reasonably achievable.

Ash residues—This category of residues includes incinerator ash; inorganics; sand, slag, and crucible; graphite fines; and firebrick. These residues are grouped together because of the similar methods in which the residues will be treated and/or repackaged.

Atomic Energy Act (AEA)—A law originally enacted in 1946 and amended in 1954 that placed nuclear production and control of nuclear materials within a civilian agency, originally the Atomic Energy Commission. The Atomic Energy Commission was replaced by the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy.

Beta emitter—A radioactive substance that decays by releasing a beta particle.

Beta particle—A particle emitted in the radioactive decay of many radionuclides. A beta particle is identical to an electron. It has a short range in air and a small ability to penetrate other materials.

Blend down—A process in which an appropriate material is added to a plutonium-bearing material to reduce the concentration of plutonium in the material. The quantity of plutonium in the material remains the same while the total quantity of material increases.

Bounded—Producing the greatest consequences of any assessment of impacts associated with normal or abnormal operations.

Button—Plutonium metal in a hemispherical shape, weighing approximately 2 kilograms.

Calcination—A process in which a material is heated to a high temperature to drive off volatile matter (to remove organic material) or to effect changes (as oxidation or pulverization or to convert it to nodular form). Calciners and nodulizing kilns are considered to be similar units. The temperature is kept below the fusion point.

Canister—A stainless-steel container in which nuclear material is sealed.

Canyon—A heavily shielded building at the Savannah River Site used in the chemical processing of radioactive materials to recover special isotopes. Operation and maintenance are performed by remote control.

Cask—A heavily shielded massive container for holding nuclear materials during shipment.

Cementation—A process in which cement and water are added to a plutonium-bearing material to create a concrete or grout material form.

Ceramification—A process in which an inorganic oxide is heated at high temperatures to the point at which oxide particles begin to fuse together. This forms a ceramic material.

Characterization—The determination of waste or residue composition and/or properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done to determine appropriate storage, treatment, handling, transportation, and disposal requirements.

Cold Ceramification—A process that stabilizes materials (e.g., residues) by converting them into chemically bonded phosphate ceramics.

Contact-handled waste—Packaged waste whose external surface dose rate does not exceed 200 mrem per hour.

Contamination—The deposition of undesirable radioactive material on the surfaces of structures, areas, objects, or personnel.

Criticality—The conditions in which a system is capable of sustaining a nuclear chain reaction.

Curie—The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of the isotope radium-226. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

Decay (radioactive)—Spontaneous disintegration of the nucleus of an unstable atom, resulting in the emission of particles and energy.

Decontamination—Removal of unwanted radioactive or hazardous contamination by a chemical or mechanical process.

Depleted uranium—Uranium that, through the process of enrichment, has been stripped of most of the uranium-235 it once contained, so that it has more uranium-238 than natural uranium. It is used as shielding, in some parts of nuclear weapons, and as a raw material for plutonium production.

***Dissolution*—**A process in which a material is dissolved.

***DOE Orders*—**Requirements internal to the U.S. Department of Energy that establish DOE policy and procedures, including those for compliance with applicable laws.

***Dose (or radiation dose)*—**A generic term that means absorbed dose, effective dose equivalent, committed effective dose equivalent, or total effective dose equivalent as defined elsewhere in this glossary.

***Dose rate*—**The radiation dose delivered per unit time (e.g., rem per year).

***Dry/Repacks*—**This category includes all inorganic residues resulting from production operations. (Formerly called *Inorganics*.)

***Effluent*—**A gas or liquid discharged into the environment.

***Enriched uranium*—**Uranium that has greater amounts of the isotope uranium-235 than occur naturally. Naturally occurring uranium is nominally 0.720 percent uranium-235.

***Environmental Impact Statement (EIS)*—**A document required of Federal agencies by NEPA for major Federal actions or legislation with potential for significantly affecting the environment. A tool for decison making, it describes the potential impacts of the proposed and alternative actions.

***Fissile material*—**Any material fissionable by thermal (slow) neutrons; the two primary fissile isotopes are uranium-235 and plutonium-239.

***Fission*—**The splitting or breaking of a nucleus into at least two other nuclei and the release of a relatively large amount of energy. Two or three neutrons are usually released during this type of transformation.

***Fission products*—**The nuclei produced by fission of heavy elements, and their radioactive decay products.

***Fissionable material*—**Commonly used as a synonym for fissile material, the meaning of this term has been extended to include material that can be fissioned by fast neutrons, such as uranium-238.

***Frit*—**Finely ground glass used as feedstock input for vitrification.

***Ful Flo filter*—**A filter used to remove particulates that are 1 to 5 microns and larger, from liquid streams. The filter is packed with activated charcoal/graphite or fiberglass.

***Gamma ray*—**Very penetrating electromagnetic radiation of nuclear origin. Except for origin and energy level, identical to x-rays. Electromagnetic radiation frequently accompanying alpha and beta emissions as radioactive materials decay.

***Geologic repository*—**A place to dispose of radioactive waste deep beneath the earth's surface.

***Glovebox*—**Large enclosure that separates workers from equipment used to process hazardous material while allowing the workers to be in physical contact with the equipment; normally constructed of stainless steel with large acrylic/lead glass windows. Workers have access to equipment through the use of heavy-duty, leadimpregnated rubber gloves, the cuffs of which are sealed in portholes in the glovebox windows.

Half-life—The time in which one-half of the atoms of a particular radioactive substance disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.

Hazardous material—A substance or material in a quantity and form that may pose an unreasonable risk to health and safety or property when transported in commerce.

Hazardous substance—Any substance subject to the reporting and possible response provisions of the Clean Water Act, and the Comprehensive Environmental Response, Compensation, and Liability Act.

Hazardous waste—Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

High-efficiency particulate air (HEPA) filter—A filter with an efficiency of at least 99.95 percent used to remove particles from air exhaust streams prior to releasing to the atmosphere.

High-level waste—The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include the highly radioactive material that the NRC, consistent with existing law, determines by rule requires permanent isolation.

Immobilization—A process that converts plutonium-bearing material to a stable form for disposal.

Isotopes—Different forms of the same chemical element that differ only by the number of neutrons in their nucleus. Most elements have more than one naturally occurring isotope. Many isotopes that do not exist in nature have been produced in reactors and particle accelerators.

Item Description Code (IDC)—At Rocky Flats, solid residues are categorized by type of material and identified by these IDCs.

Lag Storage—Short-term storage for logistical reasons.

Low enriched uranium (LEU)—Uranium enriched until it consists of up to 20 percent uranium-235. Used as nuclear reactor fuel.

Low-level waste —Any radioactive waste that is not spent fuel, high-level, or transuranic waste, and does not contain hazardous waste constituents.

Management Approach—Refer to strategic management approach.

Millirem (mrem)—One-thousandth of a rem.

Mitigate—To take practicable means to avoid or minimize the potentially harmful effects of an action (e.g., environmental harm from a selected alternative).

Mixed Oxide (MOX)—A physical blend of uranium oxide and plutonium oxide which can be used as fuel in a nuclear reactor.

Mixed waste—Waste that contains both "hazardous waste" and "radioactive waste" (as defined in this glossary).

Muffle furnaces—Small (approximately 1 cubic foot) oven-like electrically-heated units, lined with refractory material, which can be used to heat material placed onto trays inserted into the unit.

National Environmental Policy Act (NEPA)—A Federal law, enacted in 1970, that requires the Federal Government to consider the environmental impacts of, and alternatives to, major proposed actions in its decision making processes. Commonly referred to by its acronym, NEPA.

Neutron—An uncharged elementary particle with a mass slightly greater than that of the proton. Neutrons are found in the nucleus of every atom heavier than hydrogen-1.

Nonproliferation—Efforts to prevent or slow the spread of nuclear weapons and the materials and technologies used to produce them.

Normal operation—All normal conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency greater than 0.1 events per year.

Nuclear weapon—Any weapon in which the explosion results from the energy released by reactions involving atomic nuclei.

Nuclide—A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

Package—For radioactive materials, the packaging together with its radioactive contents as presented for transport (the packaging plus the radioactive contents is the package).

Packaging—For radioactive materials, it may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shock to ensure compliance with U.S. Department of Transportation regulations.

Plutonium—A manmade fissile element. Pure plutonium is a silvery metal that is heavier (for a given volume) than lead. Material rich in the plutonium-239 isotope is preferred for manufacturing nuclear weapons. Plutonium-239 has a half-life of 24,000 years.

Plutonium residues—Material containing plutonium that was generated during the separation and purification of plutonium or during the manufacture of plutonium-bearing components for nuclear weapons.

Process—Any method or technique designed to change the physical or chemical character of the residue or scrub alloy to render them less hazardous, safer to transport, store or dispose of, and/or less attractive for theft.

Purex—An acronym for Plutonium-Uranium Extraction, the name of the chemical process usually used to remove plutonium and uranium from spent nuclear fuel, irradiated targets, and other nuclear materials. As used in this EIS, the PUREX process is used to separate out plutonium from residues or scrub alloy.

Pyro-oxidation—A process in which sodium carbonate is heated with a plutonium-bearing salt matrix to a high temperature to convert any reactive metals in the matrix to nonreactive oxides.

Pyrophoric—Pyrophoric liquids are any liquids that ignite spontaneously in dry or moist air at or below 54.4 degrees Centigrade (130 degrees Fahrenheit). A pyrophoric solid is any solid material, other than one classed as an explosive, which under normal conditions is liable to cause fires through friction, retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious transportation, handling, or disposal hazard. Included are spontaneously combustible and water-reactive materials.

Radiation (ionizing)—Energy transferred through space or other media in the form of particles or waves. In this document, we refer to ionizing radiation that is capable of breaking up atoms or molecules. The splitting, or decay, of unstable atoms emits ionizing radiation.

Radioactive waste—Waste that is managed for its radioactive content; solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended and of negligible economic value considering costs of recovery.

Radioactivity—The spontaneous emission of radiation from the nucleus of an atom. Radionuclides lose particles and energy through this process of radioactive decay.

Radioisotopes—Radioactive nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons.

Radionuclide—A radioactive element characterized according to its atomic mass and atomic number that can be manmade or naturally occurring.

Raschig (glass) rings—These residues originated from Process Vent Scrubber Systems and in plutonium solutions processing production tanks. The rings are small, hollow, borosilicate glass cylinders that are used to absorb neutrons and thus prevent criticality in the aforementioned production tanks. These rings are coated with insoluble plutonium compounds.

Record of Decision (ROD)—A document prepared in accordance with the requirements of 40 CFR 1505.2 and 10 CFR 1021.315 that provides a concise public record of DOE's decision on a proposed action for which an EIS was prepared. A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative, factors balanced by DOE in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and, if not, why they were not.

rem (Roentgen Equivalent Man)—A unit of radiation dose. Dose in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, distribution factor and any other necessary modifying factors (1 rem = 0.01 sievert).

Repackage—A process in which some residue materials may be removed from their current packaging containers and placed in new containers for improved safe secure storage or to meet packaging requirements for shipment.

Resource Conservation and Recovery Act (RCRA) as Amended—The statute or law that establishes, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

Risk—Expression of an impact that considers both the probability of that impact occurring and the consequences of the impact if it does occur.

Risk assessment (chemical or radiological)—The qualitative and/or quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific chemical or radiological pollutants.

Safe, secure trailer (SST)—A specially designed semitrailer, pulled by a specially designed tractor, that is used for the safe, secure transportation of cargo containing nuclear weapons or special nuclear material.

Safeguards termination limit (STL)—Concentrations of plutonium in materials (by weight percent), above which the material would be attractive as a source of plutonium.

Salt distillation—A process that separates transuranic materials from a salt matrix by distilling the salt away from any metal oxides present in the salt.

Salt scrub—A process used to recover plutonium from salt residues. The salt is heated with a mixture of aluminum and magnesium. The magnesium reacts with plutonium chloride in the salt to form plutonium metal, which forms an alloy with the aluminum called scrub alloy.

Scrub alloy—A magnesium/aluminum/americium/plutonium metal mixture that was created as an interim step in plutonium recovery.

Shredding—A process in which materials are cut into small pieces, which have a combined surface area larger than the original materials.

Special nuclear material (SNM)—Plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Nuclear Regulatory Commission, pursuant to the provisions of the Atomic Energy Act of 1954, Section 51, determines to be special nuclear material.

Spent fuel standard—A term, coined by the National Academy of Sciences and modified by DOE, meaning that alternatives for the disposition of surplus weapons-usable plutonium should seek to make this plutonium roughly as inaccessible and unattractive for weapons use as the much larger and growing stock of plutonium in civilian spent nuclear fuel.

Stabilized residues—Plutonium residues that have been processed to make them chemically stable.

Transuranic—Any element whose atomic number is higher than that of uranium (that is, atomic number 92). All transuranic elements are produced artificially and are radioactive.

Transuranic waste—Waste contaminated with alpha-emitting radionuclides with half-lives greater than 20 years and concentrations greater than 100 nanocuries/gram at time of assay.

Uranium—The basic material for nuclear technology. It is a slightly radioactive naturally occurring heavy metal that is more dense than lead. Uranium is 40 times more common than silver.

Variance (from safeguards termination limits)—Removal of requirements for strict material control and accountability as special nuclear material when evaluations demonstrate that the proposed processing method for the material, the controls in place for normal handling of transuranic waste from the processing, and the limited quantity of special nuclear material present at any particular place and time preclude the need to take additional measures to address threats of diversion and theft.

Vitrification—A process that uses glass to encapsulate or agglomerate the plutonium contained in residues or scrub alloy in order to immobilize it.

Vulnerabilities—Conditions or weaknesses that may lead to radiation exposure to the public, unnecessary or increased exposure to the workers, or release of radioactive materials to the environment.

Waste Acceptance Criteria (WAC)—The requirements specifying the characteristics of waste and waste packaging acceptable to a disposal facility and the documents and processes the generator needs to certify that waste meets applicable requirements.

Waste classification—Wastes are classified according to DOE Order 5820.2A, “Radioactive Waste Management,” and include high-level waste, transuranic waste, and low-level waste.

Waste Isolation Pilot Plant (WIPP)—A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet in operation.

Waste management—The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated surveillance and maintenance activities.

Waste minimization—An action that avoids or reduces the generation of waste by source or toxicity reduction, improves energy usage, or recycles.

Waste classification—Wastes are classified according to DOE Order 5820.2A, Radioactive Waste Management, and include high-level waste, transuranic waste, and low-level waste.

WIPP WAC—Performance based waste acceptance criteria that must be met to allow disposal at the Waste Isolation Pilot Plant (refer to “Waste Acceptance Criteria” and Waste Isolation Pilot Plant,” given above).

Appendix B
Acronyms and Abbreviations

ACB	Auxiliary Charcoal Bed
ALARA	As-Low-As-Reasonably-Achievable
APSF	Actinide Packaging and Stage Facility
CERCLA	Comprehensive Environmental Response Compensation and Liabilities Act
CFR	Code of Federal Regulations
CMR	Chemistry and Metallurgy Research Building (LANL)
CPP-603	Fuel Storage Building at INEEL
CSB	Canister Storage Building
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DWPF	Defense Waste Processing Facility
EBR	Experimental Breeder Reactor
EM	Environmental Management
ES&H	Environment, Safety and Health
ETTP	East Tennessee Technology Park
FFTF	Fast Flux Test Facility
FMF	(Argonne West)
HEU	Highly-enriched Uranium
HSP	Health and Safety Procedure
IDC	Item Description Code
IFSF	Irradiated Fuel Storage Facility

IMNM EIS	Interim Management of Nuclear Materials Environmental Impact Statement
IPM	Implementation Plan Manager
INEEL	Idaho Engineering and Environmental Laboratory
IPABS	Integrated Planning, Accountability and Budgeting System
ISSC	Interim Safe Storage Criteria
LANL	Los Alamos National Laboratory
LEU	Low-enriched Uranium
LFL	Lower Flamability Limit
LLNL	Lawrence Livermore National Laboratory
LOI	Loss On Ignition
m^3	Cubic Meters
MCO	Multi-canister Overpacks
MOX	Mixed Oxide
MSRE	Molten Salt Reactor Experiment
MTHM	Metric Tons Heavy Metal
MTU	Metric Tons Uranium
NDA	Non-detectable Activity
NEPA	National Environmental Policy Act
NMSF	Nuclear Material Storage Facility (Sandia)
NMSS	Nuclear Material Stabilization and Storage Program
ORNL	Oak Ridge National Laboratory
PDM	Plutonium Disposition Methodology
PFP	Plutonium Finishing Plant
PFP EIS	Plutonium Finishing Plant Stabilization Final Environment Impact Statement

PNL	Pacific Northwest Laboratory
POC	Pipe Overpack Component
PUREX	Plutonium Uranium Extraction
PuSAP	Plutonium Stabilization and Packaging Project
R&D	Research and Development
RBOF	Receiving Basin for Off-Site Fuels
RFETS	Rocky Flats Environmental Technology Site
RFP	Request For Proposals
RL	Richland
ROD	Record of Decision
SIMS	Safety Issues Management System
SNF	Spent Nuclear Fuel
SNM	Special Nuclear Material
SMP	Site Management Plan
SPS	Stabilization Packaging System
SRS	Savannah River Site
SRTC	Savannah River Technology Center
SS&C	Sand, Slag, and Crucible
STD	Standard
STL	Safeguards Termination Limits
TRU	Transuranic
TRUPACT	Transuranic Package Transporter
TVA	Tennessee Valley Authority
TWRS	Tank Waste Remediation System

μmho	Micro-mho (a unit of conductance)
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WSRC	Westinghouse Savannah River Company
ZPPR	Zero Power Physics Reactor (ANL-West)

Appendix C
References

Defense Nuclear Facilities Safety Board, *Recommendation 94-1: Improved Schedule for Remediation in the Defense Nuclear Facilities Complex*, letter from John T. Conway to Hazel R. O'Leary, May 26, 1994.

U. S. Department of Energy, *Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-term Storage*, DOE-STD-3013-96, Office of Defense Programs, 1996.

U. S. Department of Energy*, Defense Nuclear Facilities Safety Board Recommendation 94-1 Implementation Plan*, DOE/EM-0199, Office of Environmental Management, 1995.

U. S. Department of Energy, *Final Environmental Impact Statement on Interim Management of Nuclear Materials at the Savannah River Site*, DOE/EIS-0220, Savannah River Operations Office, 1995.

U. S. Department of Energy, *Highly Enriched Uranium Working Group Report on Environment, Safety and Health Vulnerabilities Associated with the Department's Storage of Highly Enriched Uranium*, DOE/EH-0525, Office of Environment, Safety and Health, 1996.

U. S. Department of Energy*, Accelerating Cleanup: Paths to Closure*, DOE/EM-0362, Office of Environmental Management, 1998.

U. S. Department of Energy, *Manual for Department of Energy Interface with the Defense Nuclear Facilities Safety Board,* DOE M 140.1-1A, 1997.

U. S. Department of Energy, *Off-Specification Fuel Project Plan*, DOE/MD-0008, Office of Fissile Materials Disposition, 1998.

U. S. Department of Energy, *Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage*, DOE/EH-0415, Office of Environment, Safety and Health, 1994.

U. S. Department of Energy*, Record of Decision Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site*, DOE/EIS-0277F, Rocky Flats Field Office, 1998.

U. S. Department of Energy, *Record of Decision for the Stockpile Stewardship and Management Final Programmatic Environmental Impact Statement*, DOE/EIS-0236, Office of Defense Programs, 1996.

U. S. Department of Energy, *Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, DOE/EIS-0229, Office of Fissile Materials Disposition, 1996.

U. S. Department of Energy*, Rocky Flats Closure Project Management Plan*, Rocky Flats Field Office, 1998.

U. S. Department of Energy, *Spent Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and other Reactor Irradiated Nuclear Materials and Their Environmental, Safety, and Health Vulnerabilities*, Office of Environment, Safety and Health, 1993.

U. S. Department of Energy, Surplus Plutonium Disposition Draft Environmental Impact Statement, Office of Fissile Materials Disposition, 1998.

U. S. Department of Energy, *Update on the Department of Energy's 1994 Plutonium Vulnerability Assessment for the Plutonium Finishing Plant*, HNF-3541, Richland Operations Office.

Office of the Federal Register, Code of Federal Regulations, Department of Energy Acquisition Regulation, "Integration of Environment, Safety and Health into Work Planning and Execution," (48 CFR 970.5204-2), U.S. Government Printing Office, Revised 1997.

Office of the Federal Register, Code of Federal Regulations, Department of Energy Acquisition Regulation, "Laws, regulations and DOE directives," (48 CFR 970.5204-78), U. S. Government Printing Office, Revised 1997.

Appendix D
Summary of Commitments

This attachment lists all Department commitments established in this implementation plan revision and their relationship to those included in the original IP.

Hanford Plutonium Finishing Plant

- *Commitment Statement:* Complete a programmatic optimization study for the shipping and/or processing of materials at alternate sites.
  IP Commitment Number: 101
  Due Date: February 1999
  Reason for Change: New commitment

Solutions

- *Commitment Statement:* Complete categorization of plutonium solutions (with similar characteristics to facilitate stabilization).
  IP Commitment Number: 102
  Due Date: February 1999
  Reason for Change: New commitment

- *Commitment Statement:* Complete an options analysis to determine if a magnesium oxide precipitation should be used in lieu of an ion exchange pre-treatment prior to calcining.
  IP Commitment Number: 103
  Due Date: February 1999
  Reason for Change: New commitment

- *Commitment Statement:* Initiate operation of the prototype vertical denitration calciner.
  IP Commitment Number: 104
  Due Date: May 1999
  Reason for Change: New commitment

- *Commitment Statement:* Complete installation and testing of the production vertical denitration calciner.
  IP Commitment Number: 105
  Due Date: September 1999
  Reason for Change: New commitment

- *Commitment Statement:* Complete stabilizing and packaging plutonium solutions.

IP Commitment Number: 106
Previous Due Date: January 1999
Revised Due Date: December 2001
Reason for Change: Extended shutdown of PFP stabilization activities.

Pu Metal and Oxides >50 wt%

- *Commitment Statement:* Initiate thermal stabilization of the Pu oxides and MOX >50 wt% Pu and/or Pu + U.
  IP Commitment Number: 107
  Due Date: January 1999
  Reason for Change: New commitment

- *Commitment Statement:* Complete analysis of options for using the Hanford Convenience Can vice a welded seam repackaging system for plutonium prior to repackaging in a PuSAP packaging system.
  IP Commitment Number: 108
  Due Date: February 1999
  Reason for Change: New commitment

- *Commitment Statement:* Complete evaluation of options for mitigating hazards/ concerns of stored unalloyed plutonium metal nitride and hydride formation.
  IP Commitment Number: 109
  Due Date: February 1999
  Reason for Change: New commitment

- *Commitment Statement:* Complete brushing and repackaging of metal inventory.
  IP Commitment Number: 110
  Previous Commitment: Complete metal and oxide stabilization by May 2002
  Revised Due Date: May 2002
  Reason for Change: Oxide stabilization delayed due to extended shutdown of PFP operations.

- *Commitment Statement:* Complete stabilizing and packaging of oxides >50 wt%.
  IP Commitment Number: 111
  Previous Due Date: May 2002
  Revised Due Date: December 2004
  Reason for Change: Oxide stabilization delayed due to extended shutdown of PFP operations.

Pu Metal and Oxides <50 wt%

- *Commitment Statement:* PFP will identify the technical approach for stabilization of ash residues.
  IP Commitment Number: 112
  Due Date: January 1999
  Reason for Change: New commitment

- *Commitment Statement:* Two LANL-designed pyrolysis units will be installed at Hanford or LANL for stabilization of polycubes.
  IP Commitment Number: 113
  Due Date: December 1999
  Reason for Change: New commitment

Plutonium Alloys

- *Commitment Statement:* Ship aluminum and other selected alloys to SRS.
  IP Commitment Number: 114
  Due Date: June 2001
  Reason for Change: New commitment

Polycubes

- *Commitment Statement:* Complete pyrolizing (stabilization) and packaging of polycubes
  IP Commitment Number: 115
  Previous Due Date: January 2001
  Revised Due Date: August 2002
  Reason for Change: Extended shutdown of PFP stabilization activities.

Residues

- *Commitment Statement:* Complete packaging of ash and other residues
  IP Commitment Number: *116*
  Previous Due Date: May 2002
  Revised Due Date: June 2003
  Reason for Change: Extended shutdown of PFP stabilization activities.

Hanford K-Basins

Spent Nuclear Fuel

- *Commitment Statement:* Begin fuel removal from the K-Basins to the Cold Vacuum Drying Facility.
  IP Commitment Number: 117
  Previous Due Date: December 1997
  Revised Due Date: November 2000
  Reason for Delay: Delays in construction and startup of Canister Storage Building and Cold Vacuum Drying Facility

- *Commitment Statement:* Complete fuel removal from the K-Basins to the Cold Vacuum Drying Facility.
  IP Commitment Number: 118
  Previous Due Date: December 1999
  Revised Due Date: December 2003
  Reason for Delay: Delays in construction and startup of Canister Storage Building and Cold Vacuum Drying Facility, start up pace slowed in accordance with good systems engineering practice to allow for problem identification and correction, start of K-East extended to allow incorporation of more lessons from K-West start up.

- *Commitment Statement:* Begin K-Basin sludge removal.
  IP Commitment Number: 119
  Previous Due Date: December 1997
  Revised Due Date: July 2004
  Reason for Delay: Original conceptual design was to transfer sludge directly to tank farms without treatment. Because of particle size and other concerns this is not possible. New sludge disposition concepts involving treatment are now being developed.

- *Commitment Statement:* Complete K-Basin sludge removal.
  IP Commitment Number: 120
  Previous Due Date: December 2000
  Revised Due Date: August 2005
  Reason for Delay: Original conceptual design was to transfer sludge directly to tank farms without treatment. Because of particle size and other concerns this is not possible. New sludge disposition concepts involving treatment are not being developed. Because sludge removal and treatment will no longer be done concurrently with fuel retrieval, the duration is shorter.

Savannah River

Solutions

- *Commitment Statement:* Complete stabilization of 34,000 liters of Pu-239 solutions in H-Canyon.
  IP Commitment Number: 201
  Previous Due Date: March 2000
  Revised Due Date: June 2002
  Reason for Delay: Operational delays in startup of stabilization activities and unplanned impacts of facility infrastucture maintenance.

Metal and Oxide >50% Pu

- *Commitment Statement:* Complete construction of the APSF and fully prepare it for storing SNM.
  IP Commitment Number: 202
  Previous Due Date: December 2001
  Revised Due Date: Potential delay to December 2003
  Reason for Delay: Construction completion depends on resolution of technical issues and funding availability. DOE will prioritize funding to ensure that the highest risk materials are addressed first. DOE will ensure that potential delay in APSF construction will not result in a degradation of the safety posture at SRS or other sites.

- *Commitment Statement:* Repackage all pre-existing SRS plutonium metal and oxide to meet the metal and oxide storage standard.
  IP Commitment Number: 203
  Previous Due Date: May 2002
  Revised Due Date: No change

Residues <50% Pu

- *Commitment Statement:* Complete stabilization and packaging of solutions from dissolution of SRS plutonium residues.
  IP Commitment Number: 204
  Previous Due Date: September 2002
  Revised Due Date: September 2004
  Reason for Delay: Operational delays.

Special Isotopes

- *Commitment Statement:* Complete vitrification of Am/Cm solutions.
  IP Commitment Number: 205
  Previous Due Date: November 1999
  Revised Due Date: September 2002
  Reason for Delay: Failure of bushing melters required design, testing and approval of cylindrical melter.

- *Commitment Statement:* Complete stabilization of Np-237 solutions.
  IP Commitment Number: 206
  Previous Due Date: September 2003
  Revised Due Date: December 2005
  Reason for Delay: Change in plan from beginning stabilization in HB-Line Phase III to performing all work in HB-Line Phase II. Phase II will be available for neptunium stabilization after completion of plutonium solution and residue stabilization.

Uranium

- *Commitment Statement:* Complete disposition of pre-existing enriched uranium solutions and enriched uranium solution resulting from Mark-16 and Mark-22 SNF dissolution.
  IP Commitment Number: 207
  Previous Commitments: Complete blending down HEU solutions to a low enrichment and convert to an oxide form by December 1997.
  Disposition uranium solutions resulting from Mark-16 and Mark-22 spent nuclear fuel by April 2000.
  Revised Due Date: December 2003

Reason for Delay: Delays have occured in negotiations with TVA.

Spent Nuclear Fuel

- *Commitment Statement:* Complete Mark-16 and Mark-22 SNF dissolution.
  IP Commitment Number: 208
  Previous Due Date: December 2000
  Revised Due Date: December 2001
  Reason for Delay: Operational delays have occurred during startup and operations.

Residues and Scrub Alloy

- *Commitment Statement:* Complete stabilization and packaging of RFETS plutonium residues and scrub alloy for long-term storage.
  IP Commitment Number: 209
  Previous Commitments: Stabilize RFETS SS&C onsite by May 1998.
  Stabilize RFETS wet/miscellaneous (including flouride) residues onsite by May 2002.
  Revised Due Date: May 2002
  Reason for Delay: Change in plan to send materials to Savannah River Site.

Rocky Flats Environmental Technology Site

Solutions

- *Commitment Statement:* Complete draining and processing all B371 liquids by June 1999.
  IP Commitment Number: 301
  Previous Due Date: June 1999
  Revised Due Date: No change

- *Commitment Statement:* Drain six actinide systems in B771 by September 1999.
  IP Commitment Number: 302
  Previous Commitment: All B771 systems drained by September 1998.
  Revised Due Date: September 1999
  Reason for Delay: Change in plans to allow process equipment removal immediately following system draining.

- *Commitment Statement:* Drain eight additional actinide systems in B771 by September 2000.
  IP Commitment Number: 303
  Previous Commitment: All B771 systems drained by September 1998.
  Revised Due Date: September 2000
  Reason for Delay: Change in plans to allow process equipment removal immediately

following system draining.

- *Commitment Statement:* Complete removal of all liquids in B771 (including all non-actinide systems) by December 2001.
  IP Commitment Number: 304
  Previous Commitment: All B771 systems drained by September 1998.
  Revised Due Date: December 2001
  Reason for Delay: Change in plans to allow process equipment removal immediately following system draining.

- *Commitment Statement:* Complete processing all of the B771 liquids by March 2002.
  IP Commitment Number: 305

  Previous Due Date: June 1999
  Revised Due Date: March 2002
  Reason for Delay: Change in plans to allow process equipment removal immediately following system draining.

Metal and Oxide >50% Pu

- *Commitment Statement:* Start packaging metal or oxide into 3013 containers by January 2000.
  IP Commitment Number: 306
  Previous Commitment: Start packaging metal or oxide into 3013 containers by September 1998.
  Revised Due Date: January 2000
  Reason for Delay: Delays in procurement and testing of plutonium packaging system.

- *Commitment Statement:* Repackage all metal and oxides (except classified metal) into 3013 containers by May 2002.
  IP Commitment Number: 307
  Previous Commitment: Repackage all metal and oxides into 3013 containers by May 2002.
  Reason for Change: Change in plan to send classified metal to SRS for declassification and repackaging.

Residues <50% Pu

- *Commitment Statement:* Complete characterization of specified salt, combustible, and IDC 368 residues to a 95/5 confidence level by February 1999.
  IP Commitment Number: 308
  Previous Due Date: New commitment
  Due Date: February 1999

- *Commitment Statement:* Complete stabilizing ion exchange resins by March 1999.
  IP Commitment Number: 309
  Previous Commitment: Process and repackage wet miscellaneous residues by May 2002.
  Due Date: March 1999

- *Commitment Statement:* Stabilize high risk salts by July 1999.
  IP Commitment Number: 310
  Previous Due Date: June 1998
  Revised Due Date: July 1999
  Reason for Delay: Operational delays in startup and operation of stabilization equipment.

- *Commitment Statement:* Stabilize ash residue IDC 333 by July 1999.
  IP Commitment Number: 311
  Previous Commitment: Complete stabilization of all salts by May 2002. (IDC 333 was previously categorized as a salt residue. See Table 5.4.3.)
  Due Date: July 1999

- *Commitment Statement:* Complete repackaging of all salts by July 2000.
  IP Commitment Number: 312
  Previous Commitment: Complete stabilization of all salts by May 2002.
  Due Date: July 2000

- *Commitment Statement:* Complete shipping fluorides to SRS by September 2000.
  IP Commitment Number: 313
  Previous Commitment: Process and repackage wet miscellaneous residues by May 2002.
  Due Date: September 2000

- *Commitment Statement:* Complete shipping SS&C to SRS by November 2000.
  IP Commitment Number: 314
  Previous Commitment: Complete stabilization of SS&C by May 1998.
  Due Date: November 2000
  Reason for Change: Change in plans to send SS&C to SRS for stabilization, and delay in completion of required NEPA for transfer.

- *Commitment Statement:* Complete repackaging ash by December 2000.
  IP Commitment Number: 315
  Previous Commitment: Process and repackage ash by May 2002.
  Due Date: December 2000

- *Commitment Statement:* Complete repackaging dry/repack residues by May 2002.
  IP Commitment Number: 316
  Previous Due Date: May 2002
  Due Date: No change

- *Commitment Statement:* Complete repackaging wet/combustibles by May 2002.
  IP Commitment Number: 317
  Previous Due Date: May 2002
  Due Date: No change

Oak Ridge

Metal and Oxide >50% Pu

- *Commitment Statement:* Repackage all plutonium metals and oxides to meet the metal and oxide storage standard.
  IP Commitment Number: 401
  Previous Due Date: May 2002
  Due Date: No change

Uranium

- *Commitment Statement:* Remove uranium deposit from Auxiliary Charcoal Bed.
  IP Commitment Number: 402
  Previous Due Date: February 1999
  Due Date: No change

- *Commitment Statement:* Complete fuel and flush salt removal from MSRE by May 2002.
  IP Commitment Number: 403
  Previous Due Date: May 2002
  Due Date: No change

Los Alamos National Laboratory

Metal and Oxide >50% Pu

- *Commitment Statement:* All legacy metal and oxide[1] will be inspected and repackaged. Material designated for DOE programmatic activities will be

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[1] Legacy materials are those with a creation date before May 1994.

packaged to meet Los Alamos temporary storage criteria. Other material will be packaged to meet the long-term storage standard.
IP Commitment Number: 501
Previous Commitment: Repackage all metal and oxide to the long-term storage standard by May 2002.
Due Date: September 2003
Reason for Delay: Change in programmatic missions at LANL required a change in the disposition plans for this material and integration with the schedule for stabilizing newly generated material.

Residues <50% Pu

- *Commitment Statement:* All legacy residues will be stabilized and the plutonium recovered as oxide. Material designated for DOE programmatic activities will be packaged to meet Los Alamos temporary storage criteria. Other oxide will be packaged to meet the long-term storage standard.
  IP Commitment Number: 502
  Previous Commitment: Stabilize all residues and repackage to the long-term storage standard by May 2002.
  Due Date: September 2005
  Reason for Delay: Change in programmatic missions at LANL required a change in the disposition plans for this material and integration with the schedule for stabilizing newly generated material.

Lawrence Livermore National Laboratory

Metal and Oxide >50% Pu

- *Commitment Statement:* Complete plutonium metal and oxide repackaging by May 2002.
  IP Commitment Number: 601
  Previous Due Date: May 2002
  Due Date: No change

Residue <50% Pu

- *Commitment Statement:* Stabilize and package LLNL’s ash residues by May 2000.
  IP Commitment Number: 602
  Previous Due Date: April 1999
  Due Date: May 2000
  Reason for Delay: Extended delay in resuming stabilization activities in Building 332.

- *Commitment Statement:* Stabilize and package all other LLNL residues by February 2001.

IP Commitment Number:	603
Previous Due Date:	April 2000
Due Date:	February 2001
Reason for Delay:	Extended delay in resuming stabilization activities in Building 332.

Idaho National Environmental and Engineering Laboratory

Spent Nuclear Fuel

●	*Commitment Statement:*	Complete Fuel Removal from the CPP-603 South Basin by December 2000.
	IP Commitment Number:	701
	Previous Commitments:	Removal of all fuel not requiring overpacking by December 1998. Complete Fuel Removal from the CPP-603 by December 2000.
	Due Date:	December 2000
	Reason for Delay:	All fuel is being sent directly to dry storage without first being removed to an intermediate wet storage basin.

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Appendix E
IP Commitment Summary Schedule

This attachment provides a top-level summary time line that shows the start and end dates of resolution activities for each safety issue.

The following pages in this attachment are an illustration of the scheduled completion dates for the top-level commitments made in the Recommendation 94-1 Implementation Plan, Revision 1. Each commitment is plotted relative to a time-line that represents the extent of the time in which the Implementation Plan specifies all of the commitments therein will be completed.

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APPENDIX E

Richland 94-1 IP Commitments

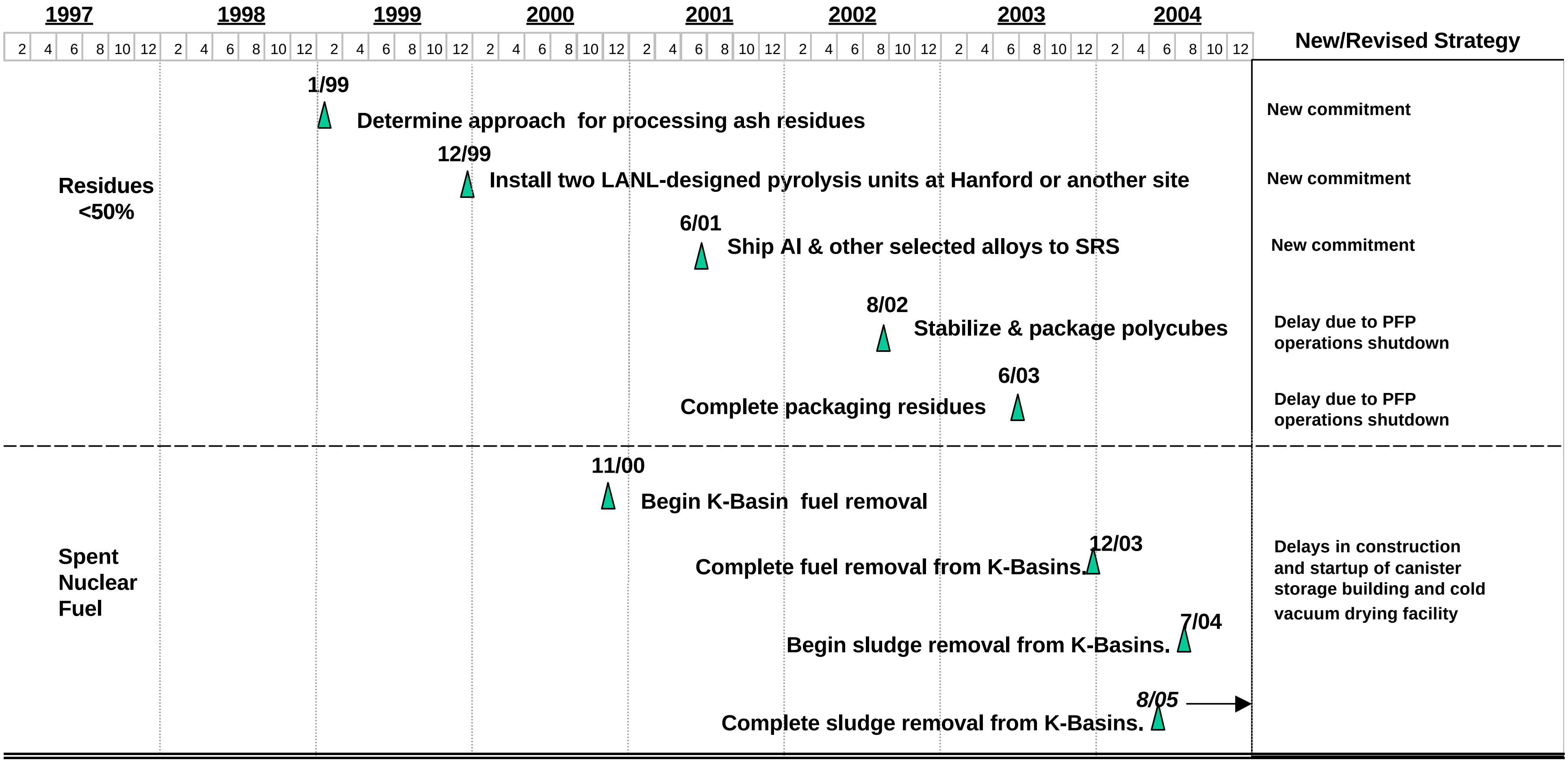
1997 1998 1999 2000 2001 2002 2003 2004

2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8 10 12

			New / Revised Strategy
General	2/99	Complete programmatic optimization study for shipping and/or processing selected 94-1 materials at alternate sites	New commitment
	2/99	Evaluate options for processing unalloyed Pu metal to meet long term storage standard	New commitment
	2/99	Complete Pu canning systems options analysis	New commitment
Solutions	2/99	Complete categorization of Pu solutions	New commitment
	2/99	Determine if magnesium oxide precipitation is alternative to ion exchange for solutions that can't be calcined	New commitment
	5/99	Startup prototype calciner	New commitment
	9/99	Startup production vertical denitration calciner	Delay due to PFP operations shutdown
	12/01	Complete Pu solutions stabilization & packaging	Delay due to PFP operations shutdown
Metals & Oxides >50%	1/99	Start thermal stabilization of Pu oxides & MOX >50 wt% Pu and / or Pu + U	New commitment
	5/02	Complete repackaging metal inventory	Delay due to PFP operations shutdown
	12/04	Complete stabilizing & packaging oxides > 50% →	Delay due to PFP operations shutdown

APPENDIX E

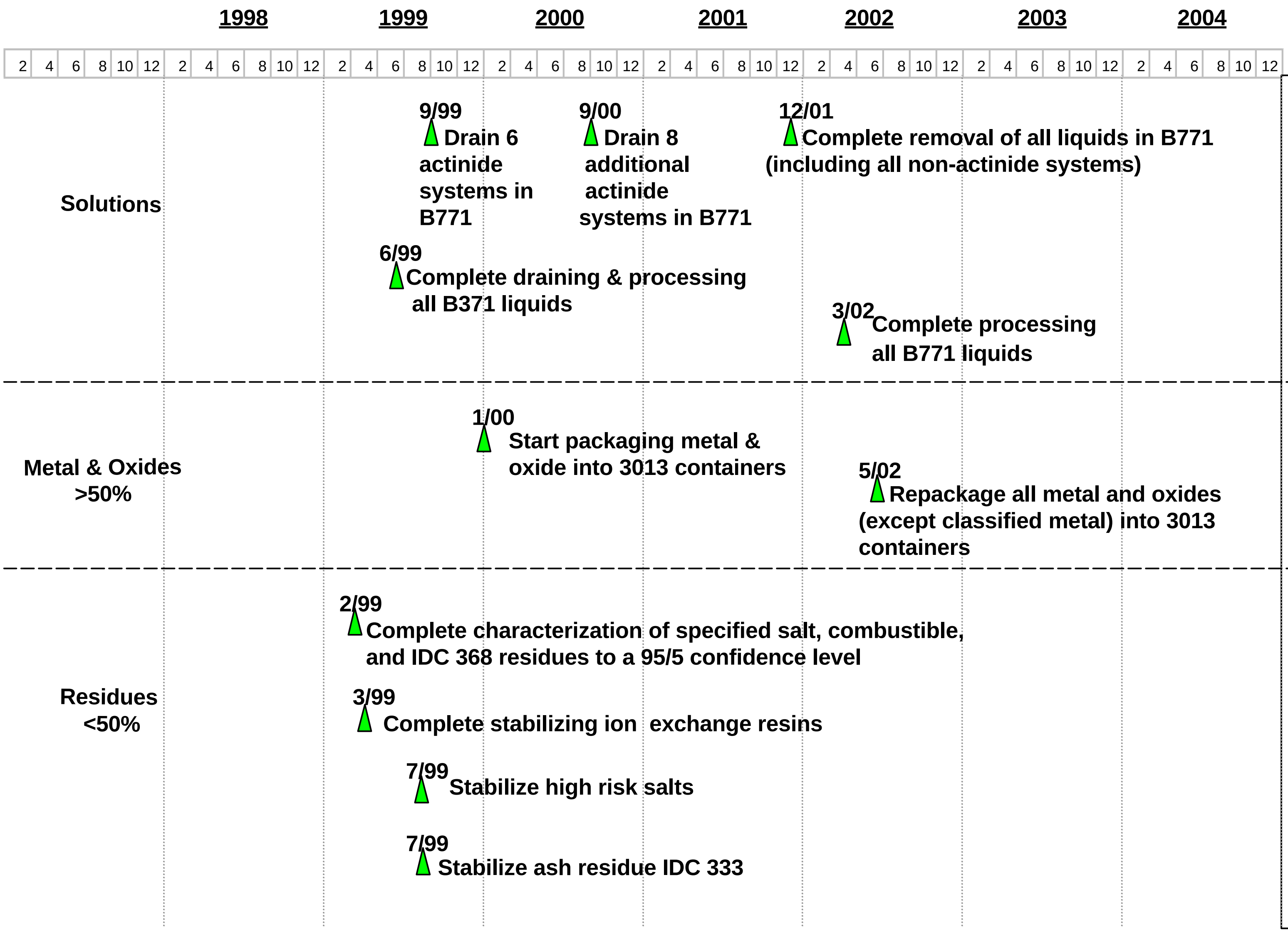
Richland 94-1 IP Commitments (Cont)



			New/Revised Strategy
Residues <50%	1/99	Determine approach for processing ash residues	New commitment
	12/99	Install two LANL-designed pyrolysis units at Hanford or another site	New commitment
	6/01	Ship Al & other selected alloys to SRS	New commitment
	8/02	Stabilize & package polycubes	Delay due to PFP operations shutdown
	6/03	Complete packaging residues	Delay due to PFP operations shutdown
Spent Nuclear Fuel	11/00	Begin K-Basin fuel removal	
	12/03	Complete fuel removal from K-Basins.	Delays in construction and startup of canister storage building and cold vacuum drying facility
	7/04	Begin sludge removal from K-Basins.	
	8/05	Complete sludge removal from K-Basins.	

APPENDIX E

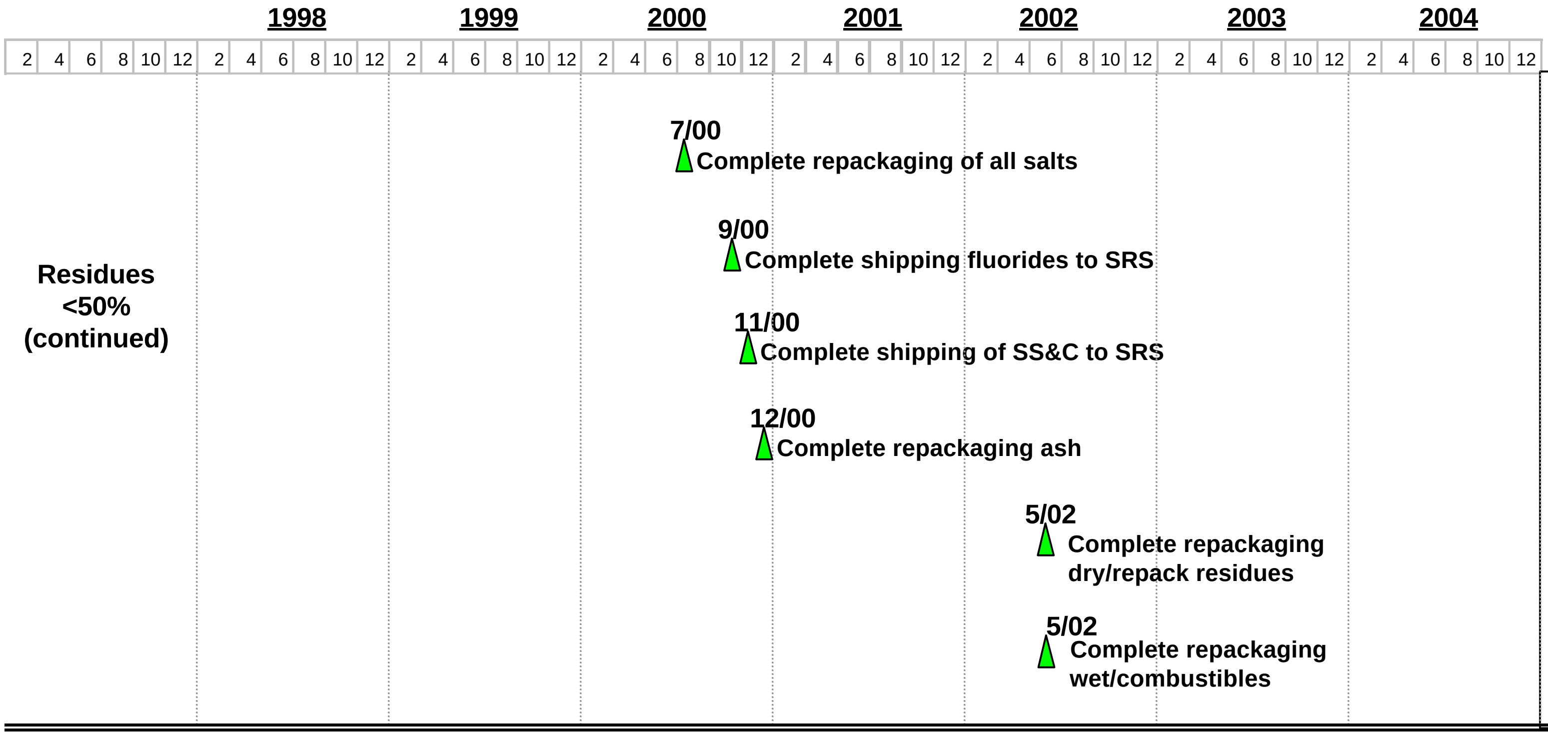
Rocky Flats 94-1 IP Commitments



			Revised Strategy
Solutions	9/99	Drain 6 actinide systems in B771	Allows process equipment removal immediately after system draining
	9/00	Drain 8 additional actinide systems in B771	
	12/01	Complete removal of all liquids in B771 (including all non-actinide systems)	
	6/99	Complete draining & processing all B371 liquids	No change
	3/02	Complete processing all B771 liquids	Allows process equipment removal immediately after system draining
Metal & Oxides >50%	1/00	Start packaging metal & oxide into 3013 containers	Delays in procurement and testing of plutonium packaging system
	5/02	Repackage all metal and oxides (except classified metal) into 3013 containers	Change in plan to send classified metal to SRS for declassification& repackaging
Residues <50%	2/99	Complete characterization of specified salt, combustible, and IDC 368 residues to a 95/5 confidence level	New commitment
	3/99	Complete stabilizing ion exchange resins	Schedule acceleration by using pipe component
	7/99	Stabilize high risk salts	Startup and equipment operation delays
	7/99	Stabilize ash residue IDC 333	IDC 333 was previously categorized as a salt residue (See Table 5.4.3)

APPENDIX E

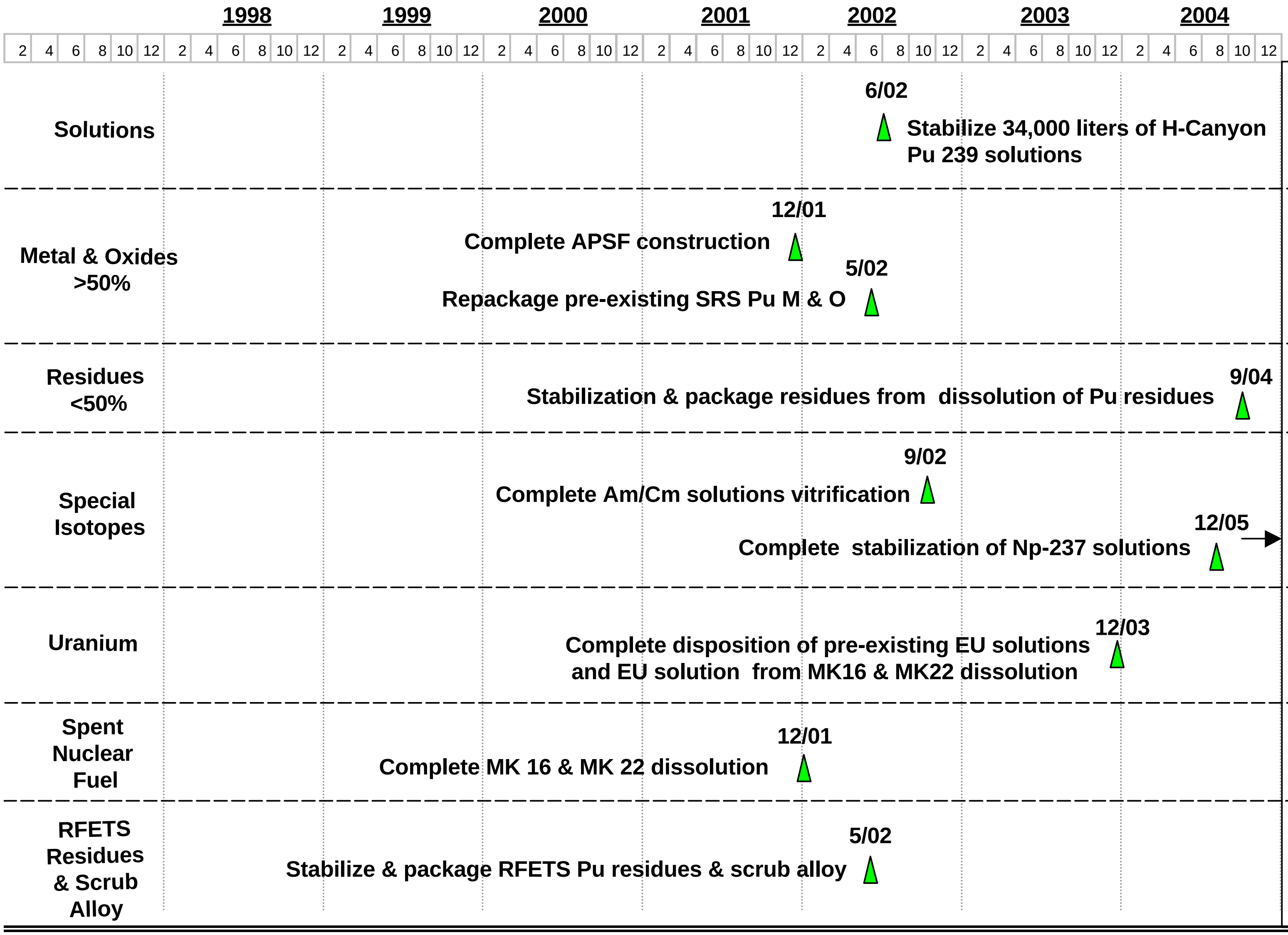
Rocky Flats 94-1 IP Commitments (Cont)



			Revised Strategy
Residues <50% (continued)	7/00	Complete repackaging of all salts	Schedule acceleration by using pipe component.
	9/00	Complete shipping fluorides to SRS	Schedule acceleration via site integration.
	11/00	Complete shipping of SS&C to SRS	NEPA delay delays transfer of SS&C to SRS
	12/00	Complete repackaging ash	Schedule acceleration by using pipe component.
	5/02	Complete repackaging dry/repack residues	No change
	5/02	Complete repackaging wet/combustibles	No change

APPENDIX E

Savannah River 94-1 IP Commitments



			Revised Strategy
Solutions	Stabilize 34,000 liters of H-Canyon Pu 239 solutions	6/02	Operational delays in startup of stabilization activities
Metal & Oxides >50%	Complete APSF construction	12/01	Technical & budget issues
	Repackage pre-existing SRS Pu M & O	5/02	Linkage to APSF
Residues <50%	Stabilization & package residues from dissolution of Pu residues	9/04	Linkage to APSF
Special Isotopes	Complete Am/Cm solutions vitrification	9/02	Delayed for design, testing, & approval of cylindrical melter.
	Complete stabilization of Np-237 solutions	12/05	Linkage to APSF
Uranium	Complete disposition of pre-existing EU solutions and EU solution from MK16 & MK22 dissolution	12/03	TVA negations for shipment of material are delayed
Spent Nuclear Fuel	Complete MK 16 & MK 22 dissolution	12/01	Operations and startup delays
RFETS Residues & Scrub Alloy	Stabilize & package RFETS Pu residues & scrub alloy	5/02	Change in plan to send materials to SRS

APPENDIX E

94-1 IP Commitments for Los Alamos, Livermore, Oak Ridge and INEEL

<u>1998</u> <u>1999</u> <u>2000</u> <u>2001</u> <u>2002</u> <u>2003</u> <u>2004</u>

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			Revised Strategy
LANL Metal & Oxide >50%	**Inspect and repackage all legacy Pu metal & oxide (materials before 05/94) for long term storage criteria**	**9/03**	**Mission change requires integrated processing with newly generated material**
LANL Residues <50%	**Stabilize legacy residues (materials before 05/94) recover plutonium as oxide & package for long term storage**	***9/05***	**Mission change requires integrated processing with newly generated material**
LLNL Metal & Oxide >50%	**Repackage Pu metal & oxide**	**5/02**	**No change**
LLNL Residues <50%	**Stabilize ash residues**	**5/00**	**Extended Building 332 shutdown delays resuming stabilization activities**
	Stabilize all other residues	**5/01**	**Extended Building 332 shutdown delays resuming stabilization operations**
OR Metal & Oxide >50%	**Repackage Pu metal & oxides to M&O standard**	**5/02**	**No change**
Uranium (MSRE)	**Remove uranium deposits from Auxiliary Charcoal Bed**	**2/99**	**No change**
	Complete fuel & flush salt removal	**5/02**	**No change**
INEEL Spent Nuclear Fuel	**Complete fuel removal from the CPP-603.**	**12/00**	**Fuel is sent directly to dry storage vice the intermediate wet storage basin**

Appendix F
Listing of Completed Actions

This attachment lists all commitments completed to date.

Hanford PFP

Ensured all bottles containing Pu solutions are properly vented, 5/95
Stabilized 220 liters of chloride solutions, 9/95
Issued clean-out and stabilization EIS ROD, 6/96
Completed solution technology development, 4/96
Completed transfer of 22,700 liters of PUREX solutions to tank farms, 4/95
Began engineering studies for a new repackaging line, 9/95
Stabilized existing inventory of low organic residues in muffle furnaces, 6/95
Stabilized 46 cans of selected RFETS ash in muffle furnaces, 1/96

Hanford SNF

Issued “Management of SNF from K-Basins” EIS ROD, 3/96
Developed K-Basins potential funding options and and acquisition strategy, 3/95
Issued K-Basin EIS NOI, 3/95
Completed K-West Basin cofferdam installation, 2/95
Completed K-East Basin cofferdam installation, 4/95
Began fuel characterization in K-Basin hot cells, 4/95
Performed K-basin sludge removal demonstration along with cofferdam installation, 12/94
Issued K-Basin Integrated Path Forward Schedule providing details of major system acquisitions and materials movements, 4/95

Savannah River

Restarted F-Canyon Second Pu Cycle Solvent Extraction (Operational Readiness Reviews), 2/95
Repackaged all 14 containers of Pu-238 solids, 3/95
Restarted FB-Line (Operational Readiness Reviews), 11/95
Restarted full F-Canyon Operations (Operational ReadinessReviews), 2/96
Stabilized 303,000 liters of Pu solutions, 4/96
Repackaged all plutonium metal in contact with plastic, 11/95
Completed SNF storage basin upgrades, 5/96
Stabilized all 3,500 gallons of Pu-242 solution, 12/96
Stabilized all 15,884 Mk-31 targets, 3/97
Restarted H-Canyon dissolving of Mk-22 SNF (Operational ReadinessReviews), 7/97
Started bagless transfer repackaging of Pu metal (Readiness Assessments), 8/97
Demonstrated direct casting for stabilization of miscellaneous Pu metal, 6/96
Started HB-Line Dissolving of Pu-239 residues (Operational Readiness Reviews), 3/98

Restarted H-Canyon First Cycle Solvent Extraction (Readiness Assessments), 5/98
Dissolved all 128 containers of Sand, Slag and Crucible residue, 7/98

Rocky Flats

Completed NEPA analysis (an Environmental Assessment) for solution stabilization, 4/95
Started draining B771 hydroxide tanks and begin processing, 11/96
Completed draining four (4) B771 hydroxide tanks, 8/96
Completed B771 hydroxide precipitation process, 3/97
Started draining four (4) B771 high-level tanks and begin processing, 9/97
Started draining B371 tanks and begin processing, 12/96
Completed draining six (6) B371 Cat B tanks, 2/97
Completed draining one (1) B371 criticality tank, 5/97
Completed processing liquids from seven (7) B371 tanks, 6/97
Started tap and drain of B771 room/systems, 1/98
Completed processing liquids from the B771 high-level tanks and B371 bottles, 7/98
Completed draining four (4) B771 high-level tanks, 12/97
Completed draining of remaining B371 criticality line tanks, 2/98
Started tap and drain of B371 room/systems, 6/98
Thermally stabilized the existing backlog of all known RFETS reactive Pu oxide (63 kgs), 1/97
Repackaged a total of 256 items in B707 where Pu is in direct contact with plastic, 11/95
Repackaged 1,602 Pu metal items not in direct contact, but in proximity to, plastic, 12/96
Repackaged all Pu metal in direct contact with plastic, 5/97
Conducted sampling and inspection to determine relative risk and for repackaging Pu metals and oxides in close proximity to plastic and other synthetic amaterials, 9/95
Vented 700 unvented residue drums, 12/95
Vented 2,045 residue drums with a pootential for hydrogen gas generation, 9/95
Began stabilization by pyrochemical oxidation 6,000 kg of higher-risk salts, 1/98
Vented all inorganic residues, 12/95
Vented all wet/miscellaneous residues, 12/95
Began bottling and shipping 2,700 liters of HEU solutions offsite for stabilization, 8/96
Removed all HEU uranyl nitrate solutions (2,700 liters) from B886 and completed all shipments offsite, 11/96

Oak Ridge

Placed K-25/K-29 Category I deposits in a safe configuration, 12/97
Placed K-25/K-29 Category II deposits in a safe configuration, 1/98
Completed MSRE interim corrctive measures; drain water from the ACB cell, partition the off-gas system, eliminate the water sources, 11/95

Los Alamos

Stabilized high-risk vault items to meet the long-term storage standards, 7/98
Completed peer review of packaging operations for long-term storage, 4/95
Integrated and demonstrated repackaging operations at the TA-55 Pu facility, 4/95
Began repackaging of Pu metal and oxide at the TA-55 Pu facility, 5/95
Stabilzed 220 kgs of residues, 10/95
Developed risk-based, complex-wide categorization and prioritization criteria that all stored residues will be required to meet, 3/96
Performed a 100% inspection of vault inventory, 4/95
Recovered 100 neutron sources, 4/95
Processed 90% of analytical solutions, 8/95
Processed 100 kgs of sand, slag and crucible materials, 4/95
Processed 70 kgs of hydroxide solids, 4/95

Lawrence Livermore National Laboratory

Began inspection of Pu metal items, 4/95
Completed trade-off study to develop plans for the stabilization and packaging of ash/residues for long-term storage, 11/96

Idaho National Engineering and Environmental Laboratory

Moved an additional 189 SNF units from CPP-603 North and Middle Fuel Storage Facility to CPP-666, 9/95
Moved all SNF (6.84 metric tons) from CPP-603 North/Middle Basins to CPP-603, 8/96
Began movement of CPP-603 South Basin SNF, 5/95
Constructed and started CPP-603 dry storage overpacking from CPP-603, 7/97

Mound

Repackaged all Pu metal in direct contact with plastic, 9/96
Repackaged all Pu metals and oxides to meet the DOE metal and oxide storage standard, 3/97

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Appendix G
Summary of 94-1 Research and Development Program

Background

Recommendation 94-1, Sub-recommendation (2), states:

> *"...a research program [should] be established to fill any gaps in the information base needed for choosing among the alternate processes to be used in safe interim conversion of various types of fissile materials to optimal forms for safe interim storage and the longer term disposition. Development of this research program should be addressed in the program plan called for by [the Board]."*

The Department of Energy chartered a Research Committee through the Nuclear Materials Stabilization Task Group in March 1995, which developed and issued the *94-1 Research and Development Plan* in November 1995.

To ensure the technology needs for stabilization continue to be addressed and that the R&D Plan reflects the current needs and status of the complex, the Plutonium Focus Area (PFA) was established by DOE in October 1995 under the DOE Idaho Operations Office (DOE-ID), with support from Lockheed Martin Idaho Technologies Company (LMITCO) and Argonne National Laboratory (ANL). As part of its responsibility, the PFA organized a Technical Advisory Panel (TAP) to update and revise the R&D Plan annually. The first update was issued in November 1996 and the most recent update, Revision 3 dated September 1998, has been issued.

The R&D Plan provides a thorough evaluation of progress and R&D needs to meet 94-1 materials stabilization and storage commitments. The Plan also identifies R&D needs caused by interfacing DOE programs (i.e., DOE programs wherein information or requirements are communicated or agreed upon in support of nuclear materials stabilization and disposition), anticipates possible disposition paths for nuclear materials, and documents resulting research requirements. These requirements may change as disposition paths become more certain. Thus, this plan represents snapshots of progress at the time of Plan preparation.

Revision 0 of this Plan (November 1995) catalogued R&D needs to address nuclear material stabilization issues. Revision 1 (November 1996) narrowed the focus of those needs to more effectively target specific problem areas. Revision 2 (November 1997) indicated many medium risk and two high risk technologies in the complex wide stabilization baseline that placed the 94-1 milestone commitments at risk. Many of these risks have been currently mitigated, e.g., the pipe overpack component (POC) at RFETS for disposing residues, or by committing to more realistic milestone dates at Hanford and SRS. The current revision (September 1998) incorporates results from anticipated complex wide 94-1 IP changes that will be finalized in December 1998. In addition, it identifies areas that require more oversight by the Nuclear Materials Stewardship Program Office and DOE field offices, and areas that require further interface negotiation and policy evaluation by DOE.

The R&D Plan is circulated in the R&D community to generate comments and solutions to identified problems (promising technology solutions are submitted as white papers) in response to R&D gaps and programmatic risks identified in the Plan. Additionally, Los Alamos National Laboratory (LANL), as the Lead Laboratory for 94-1 R&D, prepares a Program Plan in response to the recommendations from the R&D Plan. During FY 1998, the PFA TAP reviewed submitted white papers and provided peer reviews of LANL applied and core technologies. The TAP also conducts smaller reviews at various sites to review site-specific R&D needs.

The R&D Plan is closely coordinated with the 94-1 Implementation Plan (IP). Changes in baseline technology selection and in operational R&D need dates for technologies are extracted from the IP updates for inclusion in this R&D Plan. The TAP assessed technical maturity of the sites' baselines from the IP and, in instances where the TAP believed there were gaps or high programmatic risks in the new technology baseline, recommended backup technologies for inclusion in the R&D Plan.

Interfacing DOE programs are also integrated into the R&D Plan. Updates of various policy and technical documentation that have an impact on the stabilization of 94-1 materials are closely reviewed. In particular for this R&D Plan, materials stewardship, disposition, and safeguards termination requirements all impacted on the R&D requirements to ensure that technical issues are addressed and are consistent with U.S. policy.

This Appendix summarizes the current Research and Development Plan (September 1998, Revision 3) and provides further update to reflect ongoing program development efforts to prepare this IP revision.

1998 R&D Plan

As with previous revisions, the 1998 R&D Plan addresses five of the six material categories contained in the 94-1 IP, namely: plutonium solutions, plutonium metals and oxides, plutonium residues, highly enriched uranium, and special isotopes. R&D efforts related to spent nuclear fuel (SNF) stabilization are specifically excluded from the plan as these efforts are coordinated through the Technology Integration Technical Working Group, established by the Office of Spent Fuel Management.

Materials stabilization and other related research activities discussed in the FY 1998 Plan were categorized into 13 functional areas driven by requirements to stabilize and store materials. The areas are:

- Safe Storage Requirements
- Disposition Requirements
- Safeguards and Security Requirements
- Safety Requirements
- Plutonium Oxides Stabilization
- Plutonium Solutions Stabilization
- Plutonium Residues Stabilization
- Special Isotopes Stabilization
- Highly-Enriched Uranium Stabilization
- Packaging
- Surveillance and monitoring
- Core Technology
- Russian Technology Collaboration.

Each category was linked to appropriate 94-1 IP milestones that are schedule requirement needs for R&D. Schedule needs for a specific category of R&D at a specific site were determined by evaluating the programs defined in IP changes provided by each site.

Down-selected Technologies

During 1998, seven technologies were identified as “down-selected” within the R&D Plan. The PuSPS stabilization technology (Milestone IP-3.2.022) was down-selected because RFETS will use muffle furnaces for the operation and the PuSPS front-end stabilization unit would not be installed (see 1998 R&D Plan, paragraph 4.1.4).

Four technologies applicable to RFETS pyrochemical salts were down-selected as the pipe overpack component (POC) option was chosen for the disposition of salts to WIPP. If stabilizing pyrochemical salts were the only objective, then salt oxidation would be the only required R&D activity. However, pyrochemical salt oxidation is currently operational at RFETS and meets the needs for stabilization. RFETS is continuing to characterize pyrochemial salts to determine their risk and therefore do not require pyro-oxidation for stabilization. (see 1998 R&D Plan, paragraph 4.3.2.4).

Two Packaging Technologies (Milestones IP-3.2-045 and IP-3.2-014) became baseline. LANL has demonstrated electrolytic decontamination on welded stainless steel storage containers. LLNL has developed and demonstrated a system to transfer plutonium oxide powder within a glovebox without generating dust. (see 1998 R&D Plan, paragraph 7.1.4).

Path Forward

Safe Storage, Disposition and Safeguard Requirements

The 1998 R&D Plan developed seven recommendations in this area. Los Alamos must come to closure on technologies to meet the intent of the DOE-STD-3013-96 LOI testing (moisture) requirement and DOE must complete Pack-0011 for storage of materials 30–50 wt% plutonium and validate reduced temperatures for stabilizing materials >50 wt%.

EM must be actively engaged with MD in the evaluation process for impure (Pu+U) materials, and the stabilization program must monitor waste disposal sites acceptance criteria to ensure the WAC and RCRA requirements are met. Additionally, DOE must resolve the issues associated with the opening of WIPP.

Plutonium Stabilization

Eleven recommendations were developed for plutonium stabilization. Classified plutonium forms should be shipped to SRS from RFETS for declassification and storage. Hanford needs to move forward with the prototype vertical calciner to accommodate larger run times and gain confidence in the equipment.

Polycube pyrolysis needs to have an adequate DOE Headquarters monitored program of technical and programmatic progress tracking to ensure the need date is met. LLNL ash residues must be monitored closely and a review of technical and programmatic progress of stabilization must be conducted. Cold-bonded phosphate cermanification should be maintained as a backup for direct disposal of RFETS ash to WIPP.

DOE should develop a clear strategy for future plutonium scrap/residue streams and one-of-a-kind plutonium scrap/residue streams. Additionally, an assessment should be completed to determine if a multi-purpose process(es) are needed for miscellaneous residues. See the 1998 R&D Plan, Section 4 for more details.

Special Isotopes

One recommendation was developed for special isotopes. The Americium/Curium stabilization project requires close monitoring by the Nuclear Materials Stewardship Program Office (NMSPO) to ensure a startup date of October 2001. The NMSPO should develop a program review to ensure adequate resources are available of the effort. A backup sponge sorption technology (Russian) is under evaluation for Am/Cm and other solution stabilization. See the 1998 R&D Plan, Section 5 for more details.

Highly-enriched Uranium

No recommendations were developed in this section. See the 1998 R&D Plan, Section 6 for more details.

Packaging and Storage Technologies

Two recommendations were developed for packaging and storage technologies. Close tracking of the packaging portion of the PuSPS at RFETS is necessary to ensure the need date is met. For the APSF (which may become the primary site for long term storage) at SRS, closer coordination among the MIS (LANL) and IMSS (ANL-W) must be conducted. See the 1998 R&D Plan, Section 7 for more details.

Core Technologies

No recommendations were developed for the Core Technology.

Summary

In conclusion, with the technical strategy developed for most of the 94-1 materials stabilization pathways, the future R&D effort will continue its focus on the following:

- Americium/Curium solutions at SRS (vitrification/sponge sorption/other)
- PFP solutions (denitrator calciner/precipitation/other)
- Development of revised DOE-STD-3013 (technical support to broaden scope to a wider range of Pu+U materials)
- Development of surveillance and monitoring techniques for long-term vault storage of SNM
- Core technology (maintain technical expertise for SNM)