The Secretary of Energy
Washington, DC 20585

July 22, 2002

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

Dear Mr. Chairman:

Enclosed is Revision 2 of the Department of Energy's Implementation Plan for stabilization of the nuclear materials identified in Recommendation 2000-1. The primary purpose of this revision is to incorporate the revised plans and schedule for stabilizing nuclear materials at the Savannah River Site and the Los Alamos National Laboratory. This revision also updates the current status of, and changes to, other site commitments from the previous revision of January 2001.

We continue to closely track progress on all stabilization commitments and are pleased to be able to continue to show measurable progress at several sites. We will keep you and your staff informed of our progress in meeting the commitments in this plan. In particular, the commitment at Rocky Flats to complete repackaging of all remaining low-risk residues was completed on May 1, 2002. This was a significant accomplishment, as you have acknowledged in your May 22, 2002, letter.

If you have any questions, please contact Mr. Paul Golan for Environmental Management site issues, at (202) 586-7709 and for National Nuclear Security Administration site issues, contact Dr. Everet Beckner at (202) 586-2179.

Sincerely,

Spencer Abraham

Enclosure

An Implementation Plan for Stabilization and Storage of Nuclear Material

The Department of Energy Plan in Response to
DNFSB Recommendation 2000-1
Revision 2

July 2002

U. S. Department of Energy
Office of Environmental Management

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EXECUTIVE SUMMARY

The Department of Energy (DOE, or Department) has responsibility for safe management and cleanup of facilities and sites of the former nuclear weapons complex that are no longer in use. The Defense Nuclear Facilities Safety Board (DNFSB, or Board) was chartered by Congress in an independent oversight role for defense facility and safety-related issues. Nuclear materials that are weapons-useable, or that pose significant safety concerns (e.g., criticality) have been the focus of many interactions between DOE and the Board. Key documents assessing these issues are the Department's vulnerability reports of the mid-1990s and the Board's Recommendations 94-1 and 2000-1.

In Recommendation 94-1, issued May 26, 1994, 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 accepted the Board's Recommendation 94-1 on August 31, 1994, and submitted its initial Implementation Plan (IP) on February 28, 1995. This plan was later revised in December 1998 and February 2000 to show changes necessitated by technical improvements, previously unforeseen problems, and schedule changes that were encountered as site stabilization and repackaging operations progressed.

In Recommendation 2000-1, the Board reiterated the urgency of completing the nuclear material stabilization activities which had already been committed to under the IP for Recommendation 94-1. Accordingly, in the initial 2000-1 IP of June 2000, the Department proposed closure of Recommendation 94-1 while stabilization activities are tracked under Recommendation 2000-1. This plan was later revised in January 2001, mainly to incorporate changes to plans at the Los Alamos National Laboratory (LANL).

This plan represents Revision 2 to the Department's 2000-1 IP and updates the status of progress to date and future commitments associated with stabilizing, storing, and dispositioning the Department's nuclear materials. For example, this revision contains rebaselined plutonium stabilization plans at the Savannah River Site and at LANL. This document depicts commitments that are forecast at this time as achievable but that could change, particularly if current assumptions do not hold or if refinements to current knowledge call for changes.

Status of Progress to Stabilize Nuclear Materials

The Department has made significant progress to stabilize and package its nuclear materials for long-term storage and eventual disposition. For example, the most urgent concerns noted in Recommendation 94-1 have been addressed, as Recommendation 2000-1 acknowledges. Among recent accomplishments is the start-up of Plutonium Stabilization and Packaging System (PuSPS) operations at three sites: the Rocky Flats Environmental Technology Site, the Hanford Site, and the Lawrence Livermore National Laboratory (LLNL). As a result, these three sites have now begun their campaigns to stabilize and package plutonium in the 3013 containers that are specified in the safe long-term storage standard, DOE-STD-3013-2000. This plan describes more fully the status of these and other actions to eliminate the urgent risks discussed in Recommendation 94-1, and the compensatory measures put in place to ensure the safety of workers and the public until all stabilization activities are complete. Integrated Safety Management (ISM) systems are either in place or being implemented at these sites to ensure continued safe storage and stabilization of nuclear materials.

Remaining Actions Under Recommendation 2000-1

Nuclear materials that are the subject of DNFSB Recommendations 94-1 and 2000-1 are hereafter referred to as the "94-1 inventory," and are defined by the text and tables of Sections 4-5 and Appendix E. For the purposes of this IP, the Department defines closure of the actions related to Recommendation 2000-1 as follows:

- All items to be reclaimed for programmatic uses are sent to the facilities where those uses (and material management activities) will occur.
- All 94-1 plutonium metal and oxide is packaged according to the long-term storage standard, DOE-STD-3013-2000.
- 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 to be dispositioned as transuranic (TRU) waste are packaged in accordance with either the Waste Isolation Pilot Plant waste acceptance criteria or with site TRU waste operational requirements for safe on-site storage and management.
- All other 94-1 low-assay materials are packaged in accordance with either the Interim Safe Storage Criteria or the long-term storage standard, DOE-STD-3013-2000.

The summary below comes from Chapter 5's description of the remaining materials, stabilization activities, and completion dates for these actions. Appendix D offers a summary of the remaining commitments and their revised due dates.

Hanford

- All plutonium solutions will be stabilized by July 2002
- All plutonium oxide will be packaged to conform to DOE-STD-3013 or dispositioned offsite by May 2004
- Metals and the remaining 31 alloys will be packaged to conform to DOE-STD-3013 by December 2002
- All residues <30% plutonium will be packaged in pipe overpack containers by April 2004
- All plutonium polycubes will be packaged to conform to DOE-STD-3013 by March 2003
- All spent nuclear fuel and sludge will be removed from the K-Basins by August 2004

Savannah River

- All pre-existing plutonium solutions will be stabilized by December 2002

- All pre-existing metal and oxide >30% plutonium will be packaged to conform to DOE-STD-3013-2000 by December 2005
- All residues <30% plutonium will be stabilized by December 2005
- All americium/curium solutions will be transferred to the high-level waste system by March 2003
- All neptunium solutions will be stabilized by December 2006
- All Mark 16 and Mark 22 spent nuclear fuel will be dissolved by March 2004
- All uranium solutions will be dispositioned by September 2005

Rocky Flats

- All metal and oxide >30% plutonium will be packaged to conform to DOE-STD-3013-2000 by January 2003
- All plutonium residues will be packaged for off-site shipment by May 2002.

Oak Ridge

- All plutonium will be packaged and shipped off-site by May 2003

Los Alamos National Laboratory

- All organic solutions will be stabilized by December 2002
- All cellulose rag items and nitride items will be stabilized by December 2002
- All oxides will be stabilized by December 2003
- All unsheltered vessels will be cleaned by December 2006
- All residues will be packaged to meet either 3013-2000 or WIPP WAC by December 2010

Lawrence Livermore National Laboratory

- Complete plutonium metal and oxide packaging by December 2003
- Stabilize and package LLNL residues by December 2003

Current DOE Management Approach to Implement this Plan

The risk management activities outlined in this plan constitute an important part of the Department's ISM approach. As shown above, these activities occur at both the Office of Environmental Management (EM) and the National Nuclear Security Administration (NNSA) sites. For Departmental responsibility to implement this plan, the Assistant Secretary for EM (EM-1) is the Cognizant Secretarial Official (CSO). The CSO is aided by Responsible Managers (RMs) with responsibility to perform all associated planning, response, and implementation activities. The RM for EM is the Chief Operating Officer (EM-3) and the RM for NNSA is the Deputy Administrator for Defense Programs (NA-10). The RM is in turn assisted by other staff within his/her organization.

1.0 INTRODUCTION AND BACKGROUND

The Department of Energy (DOE, or Department) has responsibility for safe management and cleanup of facilities and sites of the former nuclear weapons complex that are no longer in use. The Defense Nuclear Facilities Safety Board (DNFSB, or Board) was chartered by Congress in an independent oversight role for defense facility and safety-related issues. Nuclear materials that are weapons-useable, or that pose significant safety concerns (e.g., criticality) have been the focus of many interactions between DOE and the Board (summarized below and in Appendix H). Key documents assessing these issues are the Department's vulnerability reports of the mid-1990s and the Board's Recommendations 94-1 and 2000-1 (see Appendices I-J).

To address the concerns specified in these documents, the Department has made much progress to stabilize nuclear materials for long-term storage and to make them ready for disposition. This plan is the latest representation of the status of these activities. This chapter provides an overview of context, purpose, recent progress, and a summary of future plans to complete outstanding actions on remaining inventories.

1.1 Historical Context and Purpose of this Revised Implementation Plan

In Recommendation 94-1, issued May 26, 1994, 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 accepted the Board's Recommendation on August 31, 1994, and submitted its initial Implementation Plan (IP) on February 28, 1995. Due to many ongoing events impacting the status of operations and future plans, the Department issued two revisions of the 94-1 IP in December 1998 and February 2000.

The Board issued Recommendation 2000-1 on January 14, 2000, reiterating the urgency of completing the nuclear material stabilization activities which had already been committed to under Recommendation 94-1. The Department continues to share the Board's concerns regarding nuclear materials stabilization and has taken appropriate actions. In particular, the Department has either corrected the urgent safety issues described in the original Recommendation 94-1 or else has put in place compensatory measures to protect workers and the public until stabilization can be completed. Accordingly, in the original 2000-1 IP of June 8, 2000, the Department proposed closure of Recommendation 94-1 as remaining stabilization activities are tracked under the Recommendation 2000-1 IP.

Due to mid-2000 changes to the plans at the Los Alamos National Laboratory (LANL), the Department issued the first revision to the 2000-1 IP on January 19, 2001. Subsequent Board correspondence on issues at LANL and at the Savannah River Site (SRS) called for revisions. Accordingly, those sites rebaselined their plutonium stabilization plans. The second revision to the IP contains these rebaselined SRS and LANL plans and incorporates changes at Hanford, Rocky Flats, Oak Ridge, and the Lawrence Livermore National Laboratory due to recent progress and events.

1.2 Summary of What's New in this Revision to the 2000-1 IP

This revised plan accounts for several key recent accomplishments to stabilize nuclear materials, and related issues and decisions, as summarized below.

Major Recent Accomplishments
Since the issuance of the previous revision of this plan, the Department has made significant progress to stabilize and package its nuclear materials. A watershed event in 2001 was the start-up of Plutonium Stabilization and Packaging System (PuSPS) operations at three sites: the Rocky Flats Environmental Technology Site (RFETS), the Hanford Site, and the Lawrence Livermore National Laboratory (LLNL). As a result, these three sites have now begun their campaigns to stabilize and package plutonium in the 3013 containers that are specified in the safe long-term storage standard, DOE-STD-3013-2000. Other recent site accomplishments, described more fully in Chapter 4, include stabilizing and repackaging all remaining RFETS plutonium residues.

Major Recent Decisions Reflected in this Revised IP
As indicated in recent correspondence between the Board and the Department, several developments have resulted in decisions that have changed site baseline plans. These decisions include those shown below.

1. Cancellation of the 235-F plutonium facility in favor of one in the FB-line, thereby expediting establishment of 3013 capability at the SRS.
2. Decision to transfer Am/Cm solutions to High Level Waste (HLW), thereby expediting their disposition.
3. Decision at Hanford to convert from a magnesium hydroxide to an oxalic acid precipitation process, in order to expedite the stabilization of plutonium solutions.

Chapters 4 and 5 describes these and others in greater detail.

1.3 Future Plans and Milestones

Remaining Actions Under Recommendation 2000-1
Nuclear materials that are the subject of DNFSB Recommendations 94-1 and 2000-1 are hereafter referred to as the "94-1 inventory," and are defined by the text and tables of Chapters 4-5 and Appendix E. For the purposes of this IP, the Department defines closure of the actions related to Recommendation 2000-1 as follows:

- All items to be reclaimed for programmatic uses are sent to the facilities where those uses (and material management activities) will occur.
- All 94-1 plutonium metal and oxide is packaged according to the long-term storage standard, DOE-STD-3013-2000.
- 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 to be dispositioned as transuranic (TRU) waste are packaged in accordance with either the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria or with site TRU waste operational requirements for safe on-site storage and management.

- All other 94-1 low-assay materials are packaged in accordance with either the Interim Safe Storage Criteria (ISSC) or the long-term storage standard, DOE-STD-3013-2000.

The remaining materials, stabilization activities, and completion dates for these actions are summarized below.

Hanford

- All plutonium solutions will be stabilized by July 2002. This date for stabilizing solutions is later than proposed in Revision 1 of the 2000-1 IP due to a lower-than-expected throughput using the magnesium hydroxide precipitation process. This operation now uses an oxalic acid precipitate, with a greater throughput.
- All plutonium oxide will be packaged to conform to DOE-STD-3013 or dispositioned offsite by May 2004.
- Metals and the remaining 31 alloys will be packaged to conform to DOE-STD-3013 by December 2002.
- All residues <30% plutonium will be packaged in pipe overpack containers by April 2004.
- All plutonium polycubes will be packaged to conform to DOE-STD-3013 by March 2003. This is a later date than in the previous IP because the delay in stabilizing solutions impacted the polycube schedule.
- All spent nuclear fuel and sludge will be removed from the K-Basins by August 2004.

Savannah River

- All pre-existing plutonium solutions will be stabilized by December 2002
- All pre-existing metal and oxide >30% plutonium will be packaged to conform to DOE-STD-3013-2000 by December 2005
- All residues <30% plutonium will be stabilized by December 2005
- All americium/curium solutions will be transferred to the high-level waste system by March 2003 for vitrification in the Defense Waste Processing Facility.
- All neptunium solutions will be stabilized by December 2006
- All Mark 16 and Mark 22 spent nuclear fuel will be dissolved by March 2004
- All uranium solutions will be dispositioned by September 2005

Rocky Flats

- All metal and oxide >30% plutonium will be packaged to conform to DOE-STD-3013-2000 by January 2003

Oak Ridge

- All plutonium will be packaged and shipped off-site by May 2003

Los Alamos National Laboratory

- All organic solutions will be stabilized by December 2002
- All cellulose rag items and nitride items will be stabilized by December 2002
- All oxides will be stabilized by December 2003
- All unsheltered vessels will be cleaned by December 2006
- All residues will be packaged to meet either 3013-2000 or WIPP WAC by December 2010

Lawrence Livermore National Laboratory

- Complete plutonium metal and oxide packaging by December 2003
- Stabilize and package LLNL residues by December 2003

1.4 Outline of the Rest of this IP

Chapter 2 describes the current management approach to implement this plan. As a plan, assumptions are built into the commitments represented herein, and Chapter 3 provides a succinct representation of these assumptions. Chapter 4 describes more fully the status of actions that eliminated the urgent risks discussed in Recommendation 94-1, and the compensatory measures put in place to ensure the safety of workers and the public until all stabilization activities are complete. Integrated Safety Management (ISM) systems are either in place or being implemented at these sites to ensure continued safe storage and stabilization of nuclear materials. Chapter 5 describes the remaining scope of materials and schedule for completing all of the stabilization activities discussed in Recommendation 2000-1. Chapter 6 describes the end state achieved by this plan, in which nuclear materials are either in programmatic reuse, in forms suitable for long-term storage, or, for discarded items, in forms suitable for responsible management as waste.

Appendix E describes the 94-1 inventory of materials that are in the scope of this plan. Appendix F lists actions completed to date in response to DNFSB Recommendations 94-1 and 2000-1. Appendix D catalogs all remaining specific DOE commitments related to 94-1 and 2000-1 that are discussed in Chapter 5. Appendix G discusses the current status of the research and development (R&D) program called for in the 94-1 and 2000-1 Recommendations. Appendix H briefly chronicles the history of DOE-DNFSB interactions to date associated with Recommendations 94-1 and 2000-1. Appendices I and J list those two recommendations for reference.

2.0 CURRENT DOE MANAGEMENT APPROACH TO IMPLEMENT THIS PLAN

Completing the commitments identified in this IP is one of the highest priorities of the Department. The risk management activities outlined in this plan constitute an important part of DOE's ISM approach. As currently configured, the Assistant Secretary for Environmental Management (EM-1) is the Cognizant Secretarial Official (CSO). The EM Responsible Manager (RM) is the Chief Operating Officer (EM-3), who has responsibility to perform all associated planning, response, and implementation activities at EM sites. The National Nuclear Security Administration (NNSA) RM is the Deputy Administrator for Defense Programs (NA-10) with oversight responsibility for commitments at LANL and LLNL. These RMs are in turn supported by staff within their organizations. These arrangements are discussed below in greater detail.

Responsibilities

The full responsibilities of the RM are contained in the *Interface with the Defense Nuclear Facilities Safety Board* (DOE M 140.1-1B), Section I.3.f, "Responsibilities of the Responsible Manager." These responsibilities include working directly with program offices and providing recommendations for integration of implementation activities across programs and sites. The RM and his/her staff will work with appropriate managers to ensure that stabilization activities at NNSA/DP and EM sites are completed in a safe and timely manner. Although the DP organization has recently been reorganized as part of the NNSA, its representation and responsibilities with respect to DNFSB responses has not changed.

Program direction shall pass from appropriate Program Offices in EM and NNSA to Field Offices under their cognizance. Consistent with the Department's ISM 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 RM and IPM can have a realistic assessment of progress toward meeting these commitments.

Field Office Managers are responsible for developing and executing fully resource-loaded 2000-1 management plans for their sites. These plans shall include appropriate narrative and schedules sufficient to indicate how their respective sites will meet their 2000-1 commitments.

Reporting

The commitments in this IP will be supported by resource-loaded schedules. Overall progress toward meeting Recommendation 2000-1 IP commitments will be reported monthly by each site via 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).

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 IP 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 re-issuance of the

IP. 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.

3.0 BASELINE ASSUMPTIONS

Key Assumptions
In order to achieve the commitments outlined in this IP, there are several key assumptions identified for each of the material categories presented in Chapter 5. These key assumptions include:

1. Environmental and other studies will be used to develop alternatives; selection of alternatives will be made through Records of Decision or pursuant to appropriate National Environmental Policy Act (NEPA) review. For many of the materials described in Chapter 5, the NEPA process has been completed, while for some activities, some milestone dates may be contingent in part on decisions made pursuant to additional NEPA review. The NEPA process is a key element of DOE's planning process and one of the principal means of achieving stakeholder involvement.

2. IP execution is predicted upon target level funding being provided by the Congress in an atmosphere of stable mission requirements.

3. The Research and Development (R&D) program (described in Appendix G) has provided the needed technologies to support the stabilization needs for this plan, and will be maintained to support emergent R&D needs related to stabilization and storage of nuclear materials.

4. Facilities will be operated within the context of each site’s ISM system.

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

4.0 SUMMARY OF COMPLETED ACTIONS

Several recent accomplishments and developments have occurred since the previous version of this plan was issued in January 2001. Section 4.1 below summarizes these site accomplishments. Section 4.2 discusses the issues contained in Department-Board correspondence that have resulted in changes to site baseline planned operations. Section 4.3 overviews the safety and risk management strategy embodied in this plan. Section 4.4 provides detailed site-specific descriptions of risk management activities.

4.1 Overview of Site Progress Since Previous Revision

This section summarizes key site progress made since the January 2001 issuance of the previous IP. Listed below are substantial recent accomplishments.

Hanford

- All the Plutonium Finishing Plant metals have been brushed and placed into 3013 containers. The site is working on resolution of a weld porosity issue.
- The Hanford and Rocky Flats ash residues have been packaged into pipe overpack containers.
- More than 60% of the solution inventory (by volume) has been processed through a precipitation process and are being packaged into 3013 containers, or placed in drums for eventual disposition to WIPP.
- The stabilization and packaging capacity has more than doubled with the completion of Line Item Project W-460, Stabilization and Handling System.
- Polycube stabilization was initiated.
- 50 Multicanister Overpacks have been retrieved from the current wet storage at K-Basin and moved to dry storage at the Canister Storage Building in the 200 East Area.

Savannah River

- The Department completed an interagency agreement with the Tennessee Valley Authority (TVA) to transfer uranium to TVA for use as commercial reactor fuel.
- The site stabilized all plutonium scrub alloy from Rocky Flats.
- The site completed the transfer of highly enriched uranium solution to the double-walled tank outside H-Canyon.
- The site dissolved more than 400 additional Mk-22 spent nuclear fuel assemblies.
- The site started HB-Line Phase II operations.

Rocky Flats

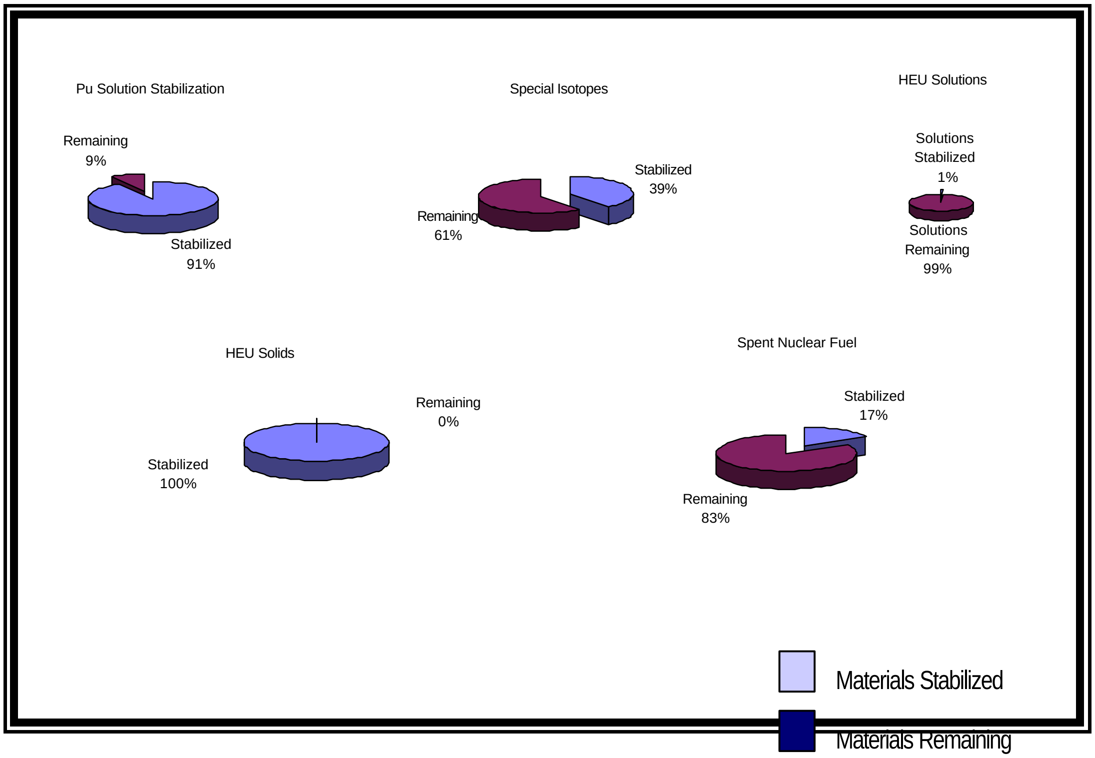
- After some construction delay, the PuSPS began operating in June 2001 to package metal and oxides into 3013 containers.
- All liquids in B771 were drained from piping systems and their removal completed in October 2001, more than two months ahead of schedule. Processing of all B771 liquids was completed

in December 2001, more than three months ahead of schedule.
- Repackaging of all residues was completed in May 2002.

Lawrence Livermore National Laboratory
- Eight excess plutonium items were added to the 94-1 inventory
- 32 plutonium items in the original 94-1 inventory were processed and packaged according to the DOE-STD-3013 standard.
- 99 plutonium items were transferred as “non-excess” inventory to meet programmatic needs.
- Approximately 300 uranium items were added to the 94-1 inventory, initially stabilized, and repackaged into 9 cans.
- The lab received approval for operation of the Plutonium Packaging System (PuPS).
- The lab installed and received approval for operation of the whole batch calcining and loss-on-ignition (LOI) system.
- The lab met SRS Stabilization and Packaging Requirements for Plutonium Bearing Materials for Storage (G-ESR-G-00035)
- The lab installed and received approval for operation of the oxide washing system.

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

Figure 4.1: Completed Actions: Material Stabilization Progress



Note: These pie charts depict complex-wide progress measured by volume for solutions and by mass for solids.

4.2 Progress to Address Recent Issues Contained in DOE-DNFSB Correspondence

During the past year, several issues emerged as sites stabilized their materials or revisited their future plans. These recent developments, contained in DOE-DNFSB correspondence and listed below, resulted in decisions to change some elements of site baseline plans.

- As noted in a DNFSB letter of May 29, 2001 and in September 2001 Departmental correspondence, the Department has decided to transfer about 14,000 liters of americium and curium (Am/Cm) solutions at the Savannah River Site to high-level waste for vitrification in the Defense Waste Processing Facility.
- As noted in a DNFSB letter of May 3, 2001, the measurement of moisture content of stabilized oxides was addressed to ensure that the 0.5wt% specification of the long-term storage standard, DOE-STD-3013-2000, would be met. The Department has responded by developing and authorizing techniques for sites' use, and in the process gained greater understanding of moisture measurement issues. Specifically, Loss-on-Ignition (LOI) is now authorized to measure moisture content for all materials that have a total actinide content greater than 80 weight percent. LOI can also be used for materials with actinide content less than 80 weight percent as long as the impurities will not further oxidize during the measurement process. Thermo-Gravimetric

Analysis (TGA), combined with either a mass spectrometer or a fourier transform infrared detector was also approved as an appropriate method to measure residual moisture on stabilized plutonium-bearing materials.

- As described in a Departmental letter to the Board on June 20, 2001, the Department has cancelled the SRS 235-F Packaging and Stabilization Project in favor of an alternative approach to establish 3013 capability within FB-Line. This action will significantly accelerate the stabilization and packaging of plutonium to meet the long-term storage standard, DOE-STD-3013. This new approach includes installation of new furnaces and an outer 3013 container welder in FB-Line. The commitments contained in Revision 1 of the 2000-1 Implementation Plan were based on installation of equipment in building 235-F in order to high fire and package plutonium to meet 3013. Compared to the 235-F project, the new FB-Line approach will accelerate the packaging of plutonium metal to meet the 3013 standard by up to three-and-a-half years, accelerate the stabilization and packaging of plutonium oxide to meet the 3013 standard by up to three years, and complete the stabilization and packaging of all SRS plutonium by up to two-and-a-half years.
- As noted in a September 19, 2001 letter to the Board, the Department is confident of safe storage for up to 50 years of properly stabilized and packaged plutonium-bearing materials, but is also evaluating disposition alternatives. As announced on January 23, 2002, the Plutonium Immobilization Plant (PIP) was cancelled. Of the 8.4 metric tons of material destined for PIP, at least 6.4 metric tons will be fabricated into Mixed Oxide (MOX) fuel. For the remaining 2 metric tons, the Department is evaluating other disposition alternatives, including additional processing that might result in the recovery of additional product suitable for fabrication as MOX fuel.

- Wet combustibles at Rocky Flats destined for WIPP caused degradation and plugging of drum filters, as described in an August 8, 2001 Department letter to the Board. A satisfactory resolution to this issue involves a revised packaging configuration that meets safe storage objectives, as described in an April 1, 2002 Department letter to the Board.

4.3 Analysis of Safety Issues and Basis for Closure

The Department's 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. Those items should be placed in improved storage as soon as possible.*

The Department has already taken action to resolve imminent safety hazards and to improve the characterization and management of all nuclear materials. This chapter describes those completed and ongoing actions to maintain these materials safely until their stabilization is completed.

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.*

Chapter 5 describes the remaining stabilization actions from the 94-1 Implementation Plan, and must be completed in response to Recommendation 2000-1.

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 of Energy chartered a Research Committee through the Nuclear Materials Stabilization Task Group in March 1995, which developed and issued an initial *94-1 Research and Development Plan* in November 1995. As described more fully in Appendix G, this R&D program has persisted to the present to assist with technical needs associated with plutonium stabilization, packaging, and long-term storage.

4.4 Site-Specific Risk Management Activities

Listed below are risk management activities for the Hanford Site, SRS, RFETS, the Oak Ridge National Laboratory (ORNL), and LLNL.

4.4.1 HANFORD

Hanford's 94-1 materials with the potential to become imminent safety hazards included plutonium solutions and certain sludges in the Plutonium Finishing Plant (PFP) as well as degraded spent nuclear fuel in water-filled storage basins. As indicated in Appendix F, actions to date have stabilized a portion of the solutions, vented solution containers, and stabilized certain sludge residues. Also, spent nuclear fuel removal was initiated at K-West Basin in December 2000. Remaining actions are discussed below.

PFP Risk Reduction Strategy

The PFP baseline is described in "Integrated Project Management Plan for Decommissioning of the PFP Nuclear Material Stabilization Project" (HNF-3617, Revision 1) as amended by Baseline Change Requests. To date, PFP has initiated all stabilization/repackaging processes; has completed stabilization and packaging of metals; and is packaging materials to meet DOE-STD-3013. The 2000-1 IP (Revision 1) projected a May 2004 date for completion of plutonium stabilization and packaging activities. This date is still the projected completion date. The complex-wide moisture measurement issue has impacted milestone dates (e.g., alloys and solutions). Hanford is working on obtaining process qualification approvals to minimize future impacts.

Materials awaiting stabilization are stored in vault and vault-like rooms. As a result of continuing storage of the PFP nuclear materials, degradation of the materials and containers is expected to continue, resulting in an increased but manageable level of risk to workers over time. In the past, approximately one to three storage containers per year required repackaging to prevent rupturing due to potential container failure as evidenced by bulging or paneling. Although a container has not ruptured in recent years, the probability that a legacy item could potentially rupture due to storage container degradation and/or material chemistry will increase with time until stabilized and packaged to meet the long-term storage standard. Storage is an on-going risk to the PFP workers, with little or no increase in risk to the public or nearby site workers. As material is stabilized, however, the overall risk to workers and the public is being reduced.

Richland included the DEAR and Laws Clauses (48 CFR 970.5223-1 and 48 CFR 970.5204-2) in the contracts in order to ensure the contractor has developed and implemented an adequate Integrated Safety Management System (ISMS). At the facility level, PFP developed the policies/procedures to implement ISMS (Phase I verification and Phase II implementation). DOE Phase II verification of ISMS implementation at PFP was completed in July 2000. DOE-RL continues to review the contractors ISMS implementation, including an annual assessment. In January 2002, OA-50 conducted an independent review of PFP's implementation, concluding that "RL and FHI have made significant improvements and established the framework for an effective ISMS program."

PFP stores solutions, metals (unalloyed and alloyed), oxides/mixed oxides, sources and standards, polycubes, fuel pins, and various residues. The following is a summary of the risks associated with storage of the plutonium material at PFP, and a list of compensatory measures.

Plutonium Solutions

PFP originally stored approximately 460 items of plutonium bearing solutions. The remaining solutions are stored in vented 10-liter Product Receiver (PR) containers in which the solutions are stored in thick-walled stainless steel vessels. Approximately 103 items that were stored in polybottles inside of thin walled stainless steel containers have been emptied and the material stabilized.

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.

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. Container corrosion rates are directly related to HCl concentration. However, recent data indicates that the chloride concentrations are low with the solution being primarily nitric acid with small amounts of chlorides. Therefore, corrosion due to chloride is not expected to be significant.

Degradation of two rubber gaskets has been observed which resulted in very minor contamination outside the PR Cans.

All containers of solution are stored in a vented configuration and triple contingency exists to preclude criticality in event of container failure. Additionally, criticality analyses demonstrate that fissile material concentration as a result of evaporation is critically safe based on geometry controls for the inner and outer containers. A full inventory was conducted of all solution containers to identify those that did not have positive vents (vent clips and/or filter installed). Checks were started in CY 1999 and to date there has been no detection of a bulging container.

Continued storage of 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.

Plutonium Metal (Unalloyed and Alloyed)

PFP has completed brushing/thermal stabilization and packaging of all unalloyed metal items. Thirty-one of the alloyed metals have been placed into pipe overpack containers; 11 packaged to meet DOE-STD-3013; 31 items are awaiting approval of an acceptable moisture measurement technique; and about 50 items were recategorized as residues (Group 2 alloys).

Plutonium Oxides and Mixed Oxides (> 30 wt% Pu +U)

PFP stores over 2,500 items of plutonium oxides (> 30 wt%Pu+U) and over 2,000 items of mixed oxides (MOX) of plutonium and uranium. 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 to existing requirements 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 the result of some corrosive contaminant in the MOX scrap.

Continued storage of plutonium oxides and mixed oxides which have not been stabilized and packaged to the DOE-STD-3013 criteria could result in an increase in risk to the workers due to potential container pressurization and continued deterioration of containers. This risk will be mitigated by the operations discussed in Section 5.

Sources and Standards (> 30 wt% Pu +U)

PFP stores approximately 170 items of plutonium-bearing sources and standards. These sources are relatively stable oxides and the risk of container breach is low.

Continued storage 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.

Polycubes

The PFP's inventory of polycubes consists of approximately 240 vented food pack cans and polyjars containing multiple ploycubes. In addition, there are approximately 20 items containing polycube scraps and miscellaneous residues resulting from the polycube fabrication process. Collectively, the polycubes contain plutonium and in some cases uranium bound in a polystyrene matrix and are over 20 years old. High radiation dose fields (over 1 R/hr on contact) have been measured caused by Americium ingrowth. 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. The polycube scraps and residues are stored in taped slip-lid containers. The taped containers provide for adequate venting to prevent build-up of hydrogen gas.

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, movement restrictions have been imposed.

Polycubes evaluated at PNNL and the PFP Laboratories demonstrated physical degradation of the cubes, and testing displayed a significant reduction in anticipated hydrogen off-gassing. Both conditions are the result of self-radiolysis occurring during storage. Polycubes with higher Pu or Pu+U loading displayed greater degradation of the cube geometry.

Continued storage of the polycubes will result in minor additional degradation of the structural integrity of the polycubes. The primary mechanism for the degradation of this material is through radiolysis. This degradation results in the formation of friable material which poses handling and storage risks. However, the increase in these risks will be minimal given the approximately thirty years these items have already been in storage, and evidence demonstrating significant reduction in generation of hydrogen gas. There is no evidence that delay will contribute to further degradation of the integrity of the filter adhesive.

Residues (SS&C, Ash, Oxides <30 wt% Pu+U, Compounds, Combustibles, Group 2 alloys, and miscellaneous residues)

PFP originally stored approximately 2,900 items of SS&C, ash and oxides <30 wt% plutonium and uranium. Hazards associated with these materials are similar to those of plutonium oxides. Repackaging of ash into pipe overpack containers has been completed (not including the cans set aside for WIPP verification sampling), and the material is stored at the Central Waste Complex.

SS&C items with high plutonium assay are stored in untinned food pack cans (4 inches X 5 ½ inch high) within lard cans. These items may also contain plutonium oxide and fluoride powders and/or plutonium metal. They may contain lab scraps and samples including fines and turnings. PFP characterized these materials using process knowledge.

PFP's inventory of residue items also includes approximately 15 items of compounds (three basic types: Pu-Zr scrap, Pu-Be scrap, and Pu-Th scrap), approximately 10 items of non-polycube combustibles, and approximately 30 items of miscellaneous scrap items, and about 50 alloys (a.k.a. Group 2 alloys).

In 2001, PFP completed an analysis of the Group 2 alloys which verified their stability for continued storage. Stabilization of residues on the current schedule will not result in an appreciable increase in risk because the residue materials have historically exhibited relatively stable characteristics.

Fuel Pins

PFP stores approximately 140 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. Currently, Hanford is planning to ship these “as is” to SRS.

Compensatory Measures

Actions taken to enhance PFP’s ability to compensate for the risks associated with the storage of these materials:

- The materials remain stored in vault or vault-like rooms restricting unnecessary worker access.

- VSIS is used to monitor most food-pack cans for bulging;

- The air in the vault rooms is monitored for alpha emitters by fixed head and Continuous Air Monitors (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 material inspected and corrective actions taken.

- Polycubes cans/jars are vented through small holes covered by individual filters.

- To guard against sparking, every solution container is electrically grounded and only non-sparking tools are used to open the containers.

- For solutions, procedures require the workers to wear respirators, in addition to protective clothing, during any activity that involves opening of containers.

K-Basins Risk Reduction Strategy

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 metric tons 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 (max) 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 (max) 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, however, and a seismic event could trigger considerable leakage.

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.

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 occurred in November 1999. The SNF Project passed the Phase II validation.

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, debris, 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 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.

4.4.2 SAVANNAH RIVER SITE

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 2000-1 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 2000-1 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.

SRS 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. 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>
HEU solution
Am/Cm solution
Np-237 solution
H-Area Pu-239 solution

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

<u>Materials in Vault Inventory</u>
Plutonium Metal and Oxide
Plutonium Residues

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

Solutions

<u>*Highly Enriched Uranium Solutions:*</u>

Prior to commencing dissolution of Mark-16/22 spent fuel, the H-Canyon processing facility at SRS 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 further processed for 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. Installed liquid level and specific gravity instruments provide an additional source of air to dilute evolved hydrogen.
- 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 changes. Action limits and required response are identified and controlled by procedure.
- Potential tank leaks are contained within sumps and would be 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.

The H-Canyon facility is processing additional Mark 16/22 fuel tubes for recovery of uranium and neptunium. The uranium solution is being stored for eventual transfer to TVA. The existing HEU solution has been refreshed and transferred to the double-walled storage tank. The H-Canyon Authorization Basis addresses the controls necessary for protection during receipt and storage. In addition, the above listed controls will also be applied to any additional A-Line uranium storage tanks

Americium/Curium Solution:

The SRS 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 had not been maintained and required extensive modification to restore it to use. A new capability and process with the ultimate goal of stabilizing the Am/Cm solution by vitrifying it inside F-Canyon was being developed. As a result of several factors, including increasing project costs and potential schedule delays, the Am/Cm solution will instead be transferred to the high level waste system and vitrified in the Defense Waste Processing Facility. 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:

- 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 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). A second backup hydrogen purge system is also installed and can be manually valved into service as an additional defense.
- Potential tank leaks are contained within the canyon cell and would be detected by increase in canyon cell sump level.

Neptunium Solution:

SRS also has 6,000 liters of neptunium (Np-237) nitrate solution in H-Canyon. Np-237 has a 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. The most significant of these controls are the following:

- Neptunium 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 is not connected to neptunium storage tanks.
- All transfer lines into and out of each tank to other canyon vessels have been

disconnected. Transfer lines may be reestablished for additional receipt of neptunium solutions during H-Canyon processing. See discussion below.

- 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 changes. Action limits and required response are identified and controlled by procedure.
- Potential tank leaks are contained within the canyon cell and would be 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 cooling water to containment if it becomes contaminated 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 H-Canyon facility is processing Mark 16/22 fuel tubes for recovery of uranium and neptunium. Unirradiated Mk-53 targets will also be processed for recovery of neptunium. The neptunium solution will be concentrated and stored in additional canyon tanks or combined with the neptunium solution currently stored in H-Canyon. The H-Canyon Authorization Basis addresses the controls necessary for neptunium storage and neptunium recovery from Mk-16/22 spent fuel. Revisions to the H-Canyon Authorization Basis may be necessary prior to processing the Mk-53 targets.

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 an oxide.

Plutonium Solutions:

SRS completed conversion of F-Canyon plutonium solutions in April 1996. The plutonium metal produced by stabilizing solutions in the FB-Line has been packaged in containers that meet the criteria of DOE-STD-3013 for inner containers, using a Bagless Transfer System (BTS). SRS completed installation of a BTS in the FB-Line facility in August 1997 as a demonstration of the new packaging technology.

The remaining solutions at SRS requiring stabilization are in the H-Canyon. 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 maintain acidity and 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. Safety of continued storage of the H-Canyon plutonium solutions until stabilization is complete has been enhanced through additional sampling and monitoring activities.

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. 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 (e.g., acidity and concentration).
- Steam supply is not connected to plutonium storage tanks.
- All transfer lines into and out of each tank to other canyon vessels have been disconnected. Transfer lines may be reestablished for additional receipt of plutonium solutions from HB-Line. See discussion below.
- 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 changes. Action limits and required response are identified and controlled by procedure.
- Potential tank leaks are contained within the canyon cell and would be 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.

In addition to storing existing plutonium solutions, the H-Canyon facility is receiving and storing plutonium-bearing scrap solution from HB-Line. The H-Canyon Authorization Basis addresses the controls necessary for protection during receipt and storage. In addition, the above listed controls will also be applied to any plutonium storage tanks.

The fourth Supplemental ROD for the IMNM EIS calls for processing these solutions through HB-Line Phase II for conversion to an oxide. The plutonium oxide will be placed in temporary storage until the capability is available to meet the DOE storage standard.

Materials in Vault Inventory

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 have been dissolved and processed to metal using the F-Canyon and the FB-Line facilities.

Plutonium Metal and Oxide:

SRS has approximately 900 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. SRS 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, containers of metal and oxide will be produced from the stabilization of solutions, targets, residues, and classified metal which will also require packaging and treatment to meet the metal and oxide storage standard. The objective is to ensure that all plutonium solids (metal and oxide) are in conformance with the DOE metal and oxide standard, DOE-STD-3013.

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 produced from stabilization activities has been packaged in inner containers that meet the requirements of DOE-STD-3013 using a bagless transfer system installed in FB-Line in August 1997. The bagless transfer system packaged these items into welded stainless steel containers with inert helium internal atmosphere, practically eliminating the potential risks associated with the previous historical packaging system.

As a result of the September 1, 1999, occurrence in which several workers were contaminated due to a faulty weld in a bagless can, several improvements in the bagless transfer system were made to reduce the potential for future weld failures. These included:

- Improved control and evaluation of welding parameters
- Improved inspection of completed welds
- Improved leak detection technique
- Increased frequency of surveillance of bagless cans

Several activities are underway to reduce risk until the remainder of the material can be repackaged. Effective controls are in place or being established 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.* Since October 1998, a small number of storage containers have been repackaged as a result of anomalies identified through the vault surveillance program.

Plutonium Residues:

SRS identified residues in several categories, including sweepings, turnings, miscellaneous plutonium metal, and sand, slag and crucible.

The ES&H Plutonium Vulnerability Assessment identifies these materials as at-risk or possibly unstable. The degree of concern varies depending on the isotopic content, chemical impurities, and packaging. 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 fourth Supplemental ROD for the IMNM EIS added processing and storage for vitrification in the DWPF as an additional stabilization method.

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.

To date, more than 1,900 residue items previously stored in FB-Line and 235-F have been stabilized.

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:

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, and approximately 1,127 Mk-22 spent fuel assemblies dissolved, the remaining inventory of SNF in the basins consists of approximately 756 Mark-16 and Mark-22 spent fuel elements. 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. However, 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.

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 de-ionizer 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.

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 de-ionization capability and a de-ionized 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 (December 12, 1995 ROD) was completed in March 1997, and dissolution of SRS Mark-16 and Mark-22 HEU SNF (February 8, 1996 ROD) 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 containing HEU will be blended down and transferred to the TVA, similar to the existing HEU solution and solutions resulting from dissolution of the Mk-16/22 spent fuel. The remainder will be transferred to the Tank Waste Farm for eventual vitrification in the Defense Waste Processing Facility.

4.4.3 ROCKY FLATS

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 listed in Appendix F, actions to date have repackaged all metal in contact with plastic, vented all drums containing plutonium residues, and shipped uranium-bearing solutions to an off-site vendor for stabilization. Remaining actions are discussed below.

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. In February 2000, the Department declared that the Rocky Flats Environmental Technology Site (RFETS) has implemented its Integrated Safety Management System.

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 371, 771, 776/777 and 779. Building 559 continues to generate small quantities of low-level waste solutions due to analytical analysis to support Site closure. The tanks that contained measurable volumes posed the most significant risk in Buildings 771 and 371; these tanks were drained, solution stabilized, and tap and draining of process systems completed. Tap and draining of Building 371 systems and processing of all Building 371 solutions were completed in June 1999. Draining from all 38 systems in Building 771 was completed in October 2001. Processing of all solution drained from B771 was completed in December 2001. As of May 2002, 37 of 38 systems have been removed.

The plutonium in these solutions is surplus to DOE's needs. Therefore, Rocky Flats solidified 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 were stored in Buildings 559, 776/777 and 779 were transferred to Building 771 for batching and Building 774 for cementation or Building 371 for processing as appropriate. Low-level solutions in Building 771, including holdup drained from piping systems and low-points, were being batched and transferred to Building 774 for cementation. Cementing the low-level solutions began in October 1993. The high-level uranium and chloride solutions were 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 were drained to bottles. The high-level solution bottles were processed through the Caustic Waste Treatment System in Building 371, which is also a hydroxide precipitation process. The effluent was transferred to Building 374 and stabilized.

The solutions in process system pipes in Building 771 were corrosive and continued to generate hydrogen and deteriorate piping integrity resulting in leaks. These solutions presented worker safety hazards from spills, and the potential for detonation and criticality. The removal and stabilization of solutions were a high priority activity at Rocky Flats. System draining and piping removal activity prioritization is based on risk. In general, the actinide systems that were leaking and generating hydrogen were removed first. Leaking non-actinide systems were considered higher risk than non-leaking actinide systems. Access to areas where the potential for leakage from tanks or pipes existed was strictly controlled. Alarm systems were in place to detect airborne contamination from spills or leaks and alert personnel. Piping system flanges and valves were encased in plastic shrink wrap to provide an additional barrier between the solutions and the workers.

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. The thermal stabilization operations of all these oxides were completed in summer 1997.

Residues

The RFETS has an inventory of approximately 106 metric tons of residues packaged in 3,930 55-gallon drums and 3,950 containers. The treatment of these residues was analyzed in the *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (August 1998). 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 reclassified as low risk due to accomplishing actions that lowered their contained storage risk (i.e., venting of drums) and 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. Table 4.4.3-1 summarizes the crosswalk between the latest path forward for residues and the original 94-1 IP.

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 were 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 majority of residues have been re-characterized as low risk.

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 RFETS 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.

Salts

All high risk salts were stabilized by July 1999. Stabilization consisted of pyro-oxidation/blending to below 10 weight percent plutonium concentration, and packaging in a pipe overpack component to meet ISSC and WIPP standards. Repackaging of all remaining salts was completed in November 2000.

Sand, Slag and Crucible

Sand, Slag and Crucible (SS&C) residues were initially planned to be shipped to SRS. SS&C residues have been characterized to a 95% confidence level and have been reclassified as low risk. However, with the opening of WIPP in March 1999 and resolution of technical issues which had made disposal of these residues at WIPP uncertain, there is no longer any advantage in shipping SS&C to SRS for processing. The SS&C would be repackaged and shipped to WIPP for disposal. This will result in final disposition several years earlier than the previous approach and will be more cost effective. The first ROD was subsequently amended (August 25, 1999) to allow SS&C residues to be repackaged and disposed of to WIPP. Repackaging operations were completed in July 2001.

Table 4.4.3-1: Crosswalk between the latest 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* 24,509 kg** IDCs 044, 310, 333, 368, 372, 373, 374, 378, 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* 3,359 kg** IDCs 387, 390, 391, 392, 393, 394, 395, 396, and 398	Repackage for disposal to WIPP	• SS&C will be shipped to WIPP (112 kg shipped to SRS as test samples)
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	Repackage for disposal to WIPP	• Fluorides will be shipped to WIPP
Dry/Repacks	7. ***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	• ***Other 78 kg*** IDCs 050 and 080	IDC 080 will be packaged in 3013s	! IDC 050 (skulls) have been dispositioned and no longer exist

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 were classified as high risk due to the fuel and oxidizer in intimate contact concern. Cementation of the ion exchange resins was completed in February 1999.

Approximately 11,000 kg of wet/combustible residues were classified as high risk. Characterization of the high risk combustibles at the 95 percent level was completed in February 1999. All high risk wet/combustible residues have been reclassified as low risk. All wet/combustibles packaging was completed in May 2002.

Fluorides

The decision to ship the fluoride residues to SRS was in the first ROD for the *Residues and Scrub Alloy EIS* (issued November 25, 1998). The fluoride residues were originally classified as a low risk and also have been confirmed to be a low risk through the characterization program. With the opening of WIPP in March 1999 and other circumstances, including delays in securing shipping container certification required prior to transporting the plutonium fluoride residues to SRS, there are no longer cost, waste management, or schedule advantages in shipping the fluoride residues to SRS for separation. The Department has decided to prepare the fluoride residues for direct disposal at WIPP. The first ROD was subsequently amended (January 11, 2001) to allow fluoride residues to be packaged and disposed of at WIPP. All fluorides repackaging was completed in November 2001.

Ash

Most of the ash residues initially classified as high risk have been re-characterized as low risk. The primary exception is IDC 333 (calcium metal), which was stabilized by April 1999. All ash packaging was completed in February 2002.

4.4.4 OAK RIDGE

Deposit Removal Project at the East Tennessee Technology Park (ETTP): All of Oak Ridge's Deposit Removal Project commitments at the ETTP have been completed . The original materials at the ETTP 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 remaining deposits 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, two safe geometry components in the K-25 Building were added to the scope of the project for security reasons.

As a result of the reassessment of the K-25 deposits, Oak Ridge submitted a proposed change to the Recommendation 94-1 IP 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.

4.4.5 LOS ALAMOS NATIONAL LABORATORY

A total of 5248 items are included in the Los Alamos National Laboratory's 00-1 inventory. These items include unsheltered vessels, programmatic materials and items excess to programmatic needs. As of June 2001, 1559 items were identified to be of programmatic use and will be repackaged to meet the interim storage criteria. These items were not included in the original scope of 94-1/00-1, however, these items are added to the overall resource loaded schedule as an integrated approach for inventory and risk management at LANL. Completion of 94-1 items may occur earlier than the overall stabilization schedule presented in Table 5-1 of Section 5.5.

The goal of the stabilization program at LANL is to process excess Special Nuclear Material (SNM) and to repack recovered materials to meet 3013 storage criteria, starting with the material/container combinations that currently pose the greatest worker risk followed by those items that pose the least risk. Of concern are excess as well as programmatic materials. To minimize worker and public risk resulting from this program as well as from potential passive container failure, it is important to rank containers by risk and, based on that ranking, to process the riskiest containers first. In October 2001, S. Boerigter published a report in which the container storage risk was examined as a product of the following four risk factors:

- container failure probability (based on historical contamination incidents)
- direct external radiation exposure
- vault room dose as a function of activity
- change in exposure caused by storage rearrangement between vault rooms

The Boerigter (2001) report provided a ranking of containers in order of that risk.

An alternative approach to risk was identified in a report by Jordan (2002). The intent of the later analysis was to rank the risk associated with a potential inhalation dose resulting from a spill accident while retrieving/processing a container from the vault. It provides a ranking by unmitigated dose risk, that is, risk established on the basis of container contents alone. A final ranking to minimize the overall risk might require consideration of the mitigating influence of the particular containers that house the materials of concern, as well as other considerations, such as availability of particular process lines. However, it is instructive that the highest-risk material categories identified with this later approach (2002), essentially match those of Boerigter's (2001) approach, lending credibility to the ranking as is.

The approach that was used for this analysis is the one traditionally used for hazard assessments that are performed for processes and materials at TA-55. In this approach, the dose to the public, as represented by the maximally exposed offsite individual (MOI), is calculated for the anticipated bounding accidents of a process. The bounding accident in this case is assumed to be a spill of a SNM filled container during handling, i.e, during retrieval from the TA-55 vault. Because the principal isotopes comprising the SNM are alpha emitters, the dose to the MOI is principally from the inhalation of respirable particles that are dispersed from the point of release to the MOI. This dose can be calculated as the product of several factors, including:

- the fraction of the contents released as respirable aerosol,
- the amount and type of radioactive material associated with this fraction, and

- the degree of dispersal of the aerosol as it transports to the MOI.

The health risk to MOI from handling a given container is proportional to dose to the MOI from the handling accident. Risk ranking containers on the basis of MOI (or worker) dose, therefore, constitutes a ranking in health risk. While this report generates specific doses, only their values relative to each other should be considered realistic.

In conclusion, the two ranking approaches, that of Boerigter on probability of failure and the present one, based on consequence of failure, identify the same highest risk material categories, namely Dioxide, Sweepings/Screenings, and ER Salt, in decreasing order of risk. A stabilization campaign that treats these three material categories first will reduce the total storage risk and will reduce that risk at the fastest rate.

4.4.6 LAWRENCE LIVERMORE NATIONAL LABORATORY

In January 2000, the 2000-1 Inventory at LLNL included 114 cans of ash residues (low grade oxide), 91 containers of metal that are either double canned or that use aluminum as the inner barrier, and 92 containers of other plutonium oxides greater than 50 wt% plutonium (the plutonium concentration cut-off specified in the DOE-STD-3013 at that time). There were also 88 cans of non-ash oxide containing <50 wt% plutonium. In the past year, 8 excess plutonium items have been added to the 94-1 inventory and 99 items have been removed for programmatic work. Approximately 300 uranium items were stabilized during FY02 that were not part of the original 94-1 inventory. These stabilized uranium items were repackaged into 9 cans for a total of 303 items that require processing to meet either the DOE-STD-3013 standard or the WIPP Waste Acceptance Criteria. Of this inventory, thirty-two plutonium items in the original 94-1 inventory have been processed and packaged in 3013 containers. This results in a total of 271 remaining items requiring processing, consisting of 28 cans of metal > 30 wt% plutonium plus uranium, 105 cans of oxide > 30 wt% plutonium plus uranium, and 138 cans of residue < 30 wt% plutonium plus uranium. This inventory is located in Building 332, which is a functioning plutonium processing and handling facility that meets federal, state, and local environmental regulations as outlined in the LLNL site-wide Environmental Impact Statement.

5.0 REMAINING SITE STABILIZATION ACTIVITIES

This chapter describes the stabilization actions which remain from the 94-1 IP, and which must be completed in response to Recommendation 2000-1. The original 94-1 IP (Rev. 0, February 1995) identified the inventories of nuclear materials requiring stabilization, now summarized in Appendix E. Two of these forms, metal and oxide, are shown in Figure 5.1. Also shown in this figure is the current interim storage container (a “Food Pack Can”) in common use at Departmental sites, and the final storage container (a 3013 can). The rest of this chapter contains site-by-site discussions of remaining inventories and stabilization actions planned for them.

Figure 5.1: Plutonium Forms and Their Packaging

Fig. 5.1(a): Corrosion on a Food Pack Can Containing Plutonium

Fig. 5.1(b): Samples of Plutonium Oxide

Fig. 5.1(c): 3.6 kg Plutonium Ingot

Fig. 5.1(d): 3013 Container for Long-Term Storage of Plutonium Materials

5.1 HANFORD

In general, the majority of plutonium materials at PFP are either thermally stabilized in furnaces and packaged in a bagless transfer system and outer can welder to meet the DOE-STD-3013 requirements, or are packaged as TRU waste for disposition to WIPP. A small amount of material may be shipped to other sites for use, or stabilized during testing by the PFP laboratory. The commitments identified represent completion dates when the material type will be dispositioned. As a result of opening and analyzing the existing storage containers, data have shown some of the materials were not placed in the correct material type. Consequently, the disposition paths for these materials were changed. It is anticipated that as PFP continues to open exiting storage containers the material type / disposition path for some materials may change. Additionally, programmatic considerations may result in changes. All changes to a material's disposition pathway has / will comply with state and federal laws and regulations, DOE Orders, etc. (e.g., safeguard termination, NEPA documentation, readiness). It is also anticipated that most of these changes will not be substantial and will not fundamentally change the strategy, scope or schedule of the IP. DOE-RL will provide characterization data to the DNFSB staff as it is developed for the remaining residues, and for items where a disposition path is changed.

Plutonium Solutions:

PFP stored approximately 460 items of plutonium-bearing solutions. PFP has four general types of solutions. The largest group (~400 items) are nitric acid solutions. These solutions range from product grade to very lean, impure solutions. The majority of these solutions will be precipitated with magnesium hydroxide or oxalate. The two families with the highest plutonium content (plutonium nitrate and critical mass laboratory nitrate) have been stabilized into oxide and are being canned into 3013 containers. The second group of solutions is the approximately 15 chloride or chloride contaminated solution items. As a result of sampling, this family was recharacterized as lab nitrate materials with trace chlorides. They have been processed using oxalic acid precipitation and are awaiting packaging.

The third group includes approximately 15 caustic solution items. Sampling and characterization of these items has also been performed. Seven were determined to be lab nitrate and have been processed using oxalic acid precipitation and are awaiting packaging. The remaining 8 are carbonate solutions. They have been sampled and the Plutonium Processing Support Laboratory is analyzing, and will make specific processing recommendations. These solutions may not be compatible with the current solution stabilization process.

The last group is the one item of low concentration organic solution. This item has been sampled and provided to the laboratory for characterization. This item will be packaged as TRU waste in an approved packaging configuration and either shipped to the Hanford Site Central Waste Complex for eventual disposition to WIPP or incorporated into on-site laboratory testing.

In September 1999, solutions stabilization process development activities using the prototype vertical denitration calciner were restarted. A limited volume of Pu solution was effectively stabilized during this testing. No additional material will be stabilized by this method.

In September 2000, PFP started the magnesium hydroxide precipitation process to convert plutonium solutions to a precipitate The precipitated plutonium hydroxide was recovered via filtration, converted to the stable oxide form by calcining in a furnace, and awaits packaging to meet DOE-STD-3013.

Upon startup of the precipitation operation it was found that each precipitation batch was yielding over three times as much precipitate as expected, due to corrosion products in the precipitate. A study was completed that determined the volume of precipitate associated with each of the five solution subcategories associated with a nitric acid solutions. The study showed that high precipitate volumes would be a significant problem for four of the five subcategories. In August 2001, oxalate precipitation was initiated to mitigate the high volume of precipitate. The resulting process is producing three to seven times fewer precipitate containers.

Approximately 1,000 liters of low concentration plutonium-bearing solutions were processed through direct discard as waste and shipped to the Hanford Site Central Waste Complex for eventual disposition to WIPP.

PFP is currently on schedule to meet this commitment.

Spent Nuclear Fuel:

To address the urgent K-Basin issues, DOE and its regulators have developed a K-Basin recommended path forward to remove the fuel from the basins (a removal action under CERCLA), to stabilize it, and to place it in a safe, secure interim storage. The Department's decision concerning this action is consistent with the ROD from the EIS for *Management of SNF from the K-Basins* at the Hanford Site, Richland, Washington, which was issued in March 1996. The key elements of the K-Basins recommended path forward are described below:

- The KW-Basins spent fuel and canisters are being retrieved from the current storage locations and cleaned, underwater, to remove corrosion products. The cleaned fuel is then 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 is then shipped to 200 East Area for interim storage in the Canister Storage Building (CSB).

- The KE-Basin canisters containing SNF will be retrieved, with sludge in the fuel canisters removed by a vacuum cleaning device, prior to transfer to KW-Basin. At the KW-Basin, the newly transferred KE-Basin fuel will be cleaned and handled similar to that described above. This transfer of fuel from KE-Basin to KW-Basin will be initiated one month before all the spent fuel, currently stored at KW-Basin are all moved to CVDF.

- The K-Basin sludge, in addition to corrosion products generated during fuel cleaning, will be accumulated at the K-Basins and later retrieved and transferred to interim storage at the T-Plant Facility located at the 200 west area, prior to processing and ultimate disposition. The sludge material will be managed as SNF while at K-Basins, and will be declared as waste, specifically remote-handled TRU, as soon as it leaves K-Basins.

- The CSB spent fuel storage configuration provides multiple barriers to ensure safe long-term interim storage. The spent nuclear fuel is being 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 have been implemented 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.

- A path forward for basin sludge that considers the probable differences between sludge in the fuel canisters and sludge lying on the basin floor has been developed. 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 known 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 Environmental Restoration Disposal Facility or to the solid waste management area to minimize the waste volume.

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

Fuel removal began December 7, 2000, from K-West Basin as the first MCO was lifted from the basin and moved to the Cold Vacuum Drying Facility for processing.

Plutonium Metals (Unalloyed and Alloyed):

PFP has completed brushing/thermal stabilization and packaging of all unalloyed metal items. Thirty-one of the alloyed metals have been placed into pipe overpack containers as residues waste; 11 were packaged to meet DOE-STD-3013; 31 alloyed items are awaiting approval of an acceptable moisture measurement technique for impure oxides; and 53 items were recategorized as residues. For the 31 items awaiting approval of a moisture measurement technique, thermal stabilization and packaging will be completed after an approved moisture method is implemented.

A weld porosity issue was identified during the qualification of the weld process to meet the SRS acceptance criteria. A resolution has been reached on future cans to be welded, and Hanford is working with SRS towards resolution of previously welded cans containing unalloyed metal items.

Plutonium Oxides and Mixed Oxides:

PFP stores approximately 2,800 plutonium oxide items and 2,300 mixed plutonium-uranium oxide items (MOX). Most of these oxides are being thermally stabilized in furnaces and will be packaged to meet long-term storage criteria. Hanford successfully restarted thermal stabilization of oxides in two furnaces in January 1999. Currently, five furnaces are operating in 234-5Z and four double capacity furnaces operating in 2736-ZB. Two bagless transfer systems and one outer can welder are utilized to package material to meet the storage standard. Moisture measurement process qualification approval is critical to remaining on schedule.

Over 900 of the oxide items listed above originally came from Rocky Flats and contain significant quantities of salts. The current baseline plan to treat these items was to use a direct thermal stabilization with a specially designed off-gas system to capture the highly corrosive gasses. Testing of that system and peripheral equipment showed that success of that method was highly improbable. PFP is reverting back to the original concept of a washing prior to thermal stabilization. An engineering study was completed that evaluated options, such as the use of existing precipitation columns, the use of ball mills to ensure complete mixing, and the use of oxide washing equipment. PFP is moving forward with the recommendation to wash the high chloride oxides in the solutions precipitation equipment prior to thermal stabilization. Laboratory tests are being conducted, and a detailed plan for modification of the precipitation columns will be prepared.

A portion of the oxides listed above, which contain low concentrations of plutonium and high uranium content, are being evaluated to determine whether they are suitable for discard to WIPP.

The oxide/mixed oxide inventory includes about 25 fluoride compounds. The PFP is converting these fluorides to oxides prior to thermally stabilizing in furnaces. A couple of Group 2 alloys will be used in the conversion process as a source of aluminum.

Additionally some items will be sent to other sites for defined use.

Sources and Standards:

Hanford plans to determine if another Departmental site or national laboratory has a beneficial use for its plutonium-bearing sources and standards. Any remaining surplus sources and standards that Hanford cannot disposition for programmatic re-use will be dispositioned via discard or 3013, as appropriate. Disposition of these items is part of the oxide commitment.

Polycubes:

The path forward for stabilization of polycubes is a one-step thermal stabilization cycle in the furnaces. This processing option will allow more cost-effective stabilization of the polycubes and reduce the duration of the polycube stabilization campaign. The resultant oxides will be packaged to DOE-STD-3013. Polycube stabilization was initiated in April 2002 on a limited basis while still completing solutions stabilization and packaging.

The furnace stabilization option will provide significant benefits to PFP including: reduced dose to the operators, less complex equipment operations, utilization of existing equipment, and require only minor changes to the existing thermal stabilization processes. Start-up of polycube stabilization will be accomplished as a feed shift. Testing performed at PNNL and PFP on both simulated and actual polycubes have demonstrated that polycube stabilization in a multi-step furnace operation can be performed safely and efficiently. Laboratory tests were completed to optimize the effective throughput.

The items containing polycube scraps and residues are planned to be stabilized using the same process as polycubes. As an alternative stabilization path forward, the scraps may be disposed of as TRU of TRU-Mixed similar to the other plutonium bearing residues.

Residues (SS&C, Ash, Oxides < 30 wt% Pu+U, Compounds, Combustibles, Group 2 Alloys, and Miscellaneous):

All ash (with the exception of those items held back for verification sampling or those used for NDA standards) was packaged into a pipe overpack container and shipped to the Central Waste Complex, for eventual disposition to WIPP. The SS&C is being packaged directly into a pipe overpack containers. The Group 2 alloys have been nearly characterized. The remaining groups of residues (oxides, compounds, combustibles, and miscellanous) need further characterization. Depending on characterization and/or requirements to meet safeguards termination requirements, the remaining residues will either be packaged directly into pipe overpack containers, stabilized, treated to remove a characteristic, or modified prior to repackaging.

DELIVERABLES/MILESTONES

Plutonium Metal

- Commitment Statement: Resolve weld porosity issues associated with metals.
  Responsibility: Manager, Richland Operations Office
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Packaging was completed in September 2001. The 3013 weld porosity issues will be resolved.
  Due Date: December 2002

Plutonium Oxide and Mixed Oxide

- Commitment Statement: Oxides will be stabilized, in furnaces and packaged to meet the DOE long-term storage standard, packaged for disposition to WIPP, or sent to another site for use. This includes sources and standards.
  Responsibility: Manager, Richland Operations Office
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Complete disposition of oxides.
  Due Date: May 2004

Plutonium Solutions

- Commitment Statement: Stabilization of solutions was initiated through the utilization of the prototype denitrator calciner. The $MgOH_2$ and oxalate precipitation processes are being utilized for processing the majority of PFP solutions and precipitate will be oxidized in furnaces and packaged to meet the DOE long term storage standard. Solutions containing low concentrations of plutonium will be dispositioned as waste.
  Responsibility: Manager, Richland Operations Office
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Complete stabilization and packaging of plutonium solutions.
  Due Date: July 2002

Polycubes

- Commitment Statement: Polycubes will be stabilized through existing furnaces. The stabilized material will be packaged to meet the DOE long-term storage standard.

  Responsibility: Manager, Richland Operations Office
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Complete stabilization and packaging of polycubes.
  Due Date: March 2003

Plutonium Alloys

- Commitment Statement: Complete packaging of remaining alloys to meet the 3013 standard.

  Responsibility: Manager, Richland Operations Office
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Package remaining alloys to meet DOE-STD-3013 criteria.
  Due Date: December 2002. Thirty-one alloys are awaiting an approved moisture measurement technique.

Residues

- Commitment Statement: PFP residues will be treated and/or packaged in a pipe over-pack to be disposed of as TRU or TRU-mixed waste per WIPP/WAC criteria.

  Responsibility: Manager, Richland Operations Office
  Applicable Facilities: Plutonium Finishing Plant
  Commitment Deliverable: Complete stabilization and packaging of residues.
  Due Date: April 2004

Spent Nuclear Fuel

- Commitment Statement: Richland will begin fuel removal from K-East Basin for transport to K-West Basin. The collection and containerization of K-East Basin sludge from canisters, floor and weasel pit will also be initiated.

  Responsibility: Manager, Richland Operations Office
  Applicable Facilities: K-East Basin Facility including the fuel retrieval, sludge removal, integrated water treatment and canister loadout systems; Sludge Transport System and Unloading System at the T-Plant Facility; Canister Transportation System; Cask Transportation System; KW-Basin Facility; Cold Vacuum Drying Facility; and Canister Storage Building.
  Commitment Deliverable: Begin fuel removal from the K-East Basin.

Due Date:	November 2002

• 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.
Responsibility:	Manager, Richland Operations Office
Applicable Facilities:	K-East Basin Facility including Sludge Transport System; and Unloading System at the T-Plant Facility.
Commitment Deliverable:	Begin sludge removal from the K-Basins.
Due Date:	December 2002

• Commitment Statement:	Complete removal of 957.115 metric tons heavy metal (MTHM) from the K-West Basin to the Cold Vacuum Drying Facility (CVDF).
Responsibility:	Manager, Richland Operations Office
Applicable Facilities:	K-West Basin Facility, including modifications; Canister Transportation System; Cask Transportation System; and Cold Vacuum Drying Facility
Commitment Deliverable:	Remove 957.115 MTHM from the K-West Basin to the CVDF.
Due Date:	December 2002

• Commitment Statement:	Richland will complete all fuel removal of all spent nuclear fuel from K-East and K-West Basins. This interim milestone will be complete when all spent nuclear fuel has been removed from the K-East and K-West Basins and has been transported to the Cold Vacuum Drying Facility. It is understood that additional fuel fragments may be discovered during removal of the sludge.
Responsibility:	Manager, Richland Operations Office
Applicable Facilities:	K-East and K-West Basins including all modifications; Cask Transportation System; Cold Vacuum Drying Facility; and Canister Storage Building.
Commitment Deliverable:	Complete fuel removal from the K-East and K-West Basins.
Due Date:	July 2004

• Commitment Statement:	Richland will complete sludge removal from the K-Basins.
Responsibility:	Manager, Richland Operations Office
Applicable Facilities:	K-East Basin Facility including Sludge Transport System; and Unloading System at the T-Plant Facility.
Commitment Deliverable:	Complete sludge removal from K-Basins.
Due Date:	August 2004

5.2 SAVANNAH RIVER SITE

In March 2000, the SRS completed a sitewide reprioritization and rebaselining with the intent of establishing an achievable schedule for completing all stabilization activities. The results of that effort were reflected in Revision 1 of this IP. Since issuance of Revision 1, progress has been made in the SRS nuclear material stabilization program and some changes to the program have occurred, including the approaches for establishing a capability to stabilize and package plutonium in accordance with DOE-STD-3013 and for stabilizing the Americium/Curium (Am/Cm) solution at the site. The discussion and commitments below have been updated to incorporate the progress and changes made since Revision 1 of the 2000-1 IP was issued.

Uranium Solutions:

DOE has entered into an Interagency Agreement 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 SRS HEU solutions (and Mk-16/22 spent nuclear fuel) 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.

Americium/Curium Solution:

Several methods for stabilizing the americium-curium solutions were evaluated during the development of the Interim Management of Nuclear Materials (IMNM) Environmental Impact Statement (EIS). The “Vitrification (F-Canyon)” alternative was selected in the IMNM EIS Record of Decision (ROD) dated December 12, 1995. That alternative was to process the Am/Cm solution into a glass matrix (vitrify) within small stainless steel canisters using equipment that would be installed in the Multi-Purpose Processing Facility (MPPF) inside F-Canyon. Revision 1 of the 2000-1 IP discussed the project underway at that time to implement that decision and contained related commitments.

Subsequent to issuance of Revision 1 of the 2000-1 IP, the increase in cost and potential schedule delay in completing the project to vitrify the solution in the MPPF, along with no identified programmatic need for the material, led the Department to reconsider the “Processing and Storage for Vitrification in the Defense Waste Processing Facility” alternative analyzed in the IMNM EIS. This alternative involves transfer of the Am/Cm solution to the HLW system for vitrification in the Defense Waste Processing Facility (DWPF). Although the HLW alternative had been considered in the past, after further evaluation it appeared more attractive for the following reasons:

- There would be a single continuous transfer of all the solution (diluted and neutralized) to the DWPF feed tank in H-Area, instead of the previously identified numerous transfers to the F-Tank Farm.
- Very little dilution would be required, resulting in approximately 10 additional DWPF canisters versus more than 100 additional canisters indicated in previous evaluations.
- The material would be included in sludge batch 3, scheduled to be vitrified in DWPF

in the 2004 - 2007 time frame instead of 2020 if transferred to the F-Tank Farm.

- The pre-conceptual total cost estimate for the HLW alternative was substantially less than the remaining cost to complete the MPPF vitrification approach.
- As long as the material is in F-Canyon, costs to maintain the facility would remain high, and the HLW alternative would result in removal of the material from F-Canyon much sooner than the MPPF vitrification project (in fact, if there were no programmatic need for the material identified by the time it was vitrified and no place to ship it for storage and use, it would have to remain stored inside F-Canyon or an alternate storage facility until such time that it could be dispositioned).

Following a thorough review of the technical issues associated with the HLW alternative, in September 2001 the MPPF vitrification project was canceled and pursuit of the HLW alternative was approved. On October 19, 2001, DOE issued an Amendment to its December 1995 ROD. The ROD amendment states that instead of implementing the "Vitrification (F-Canyon)" alternative, DOE will implement the "Processing and Storage for Vitrification in the Defense Waste Processing Facility" alternative analyzed in the IMNM EIS. Work is progressing on implementation of the HLW alternative, and transfer of the Am/Cm solution to the DWPF feed tank in H-Area for inclusion in sludge batch 3 is expected to occur by March 2003.

Neptunium Solutions:

In the fourth Supplemental ROD to the IMNM EIS, issued on October 31, 1997, DOE selected processing the neptunium 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. The Office of Nuclear Energy, Science and Technology completed and DOE issued the Final *Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (December 2000) that includes analyses concerning domestic production of Pu-238. The subsequent ROD, issued January 19, 2001, stated that DOE has decided to use existing operating reactors to produce Pu-238 for future space missions, and that the Radiochemical Engineering Development Center at Oak Ridge National Laboratory (ORNL) will be used to store the neptunium-237 transported from SRS. The Np oxide product from HB-Line will be packaged to meet or exceed shipping requirements and be shipped to ORNL, where it will be used to fabricate targets for the production of Pu-238.

During the neptunium solution stabilization, SRS 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.

Plutonium Solutions:

The IMNM EIS identifies a preferred alternative for stabilization of the Pu-239 solutions in the H-Canyon. The action indicated in the fourth Supplemental ROD is to process the solutions to oxide in the H-Canyon and HB-Line facilities. The solutions will undergo processing in the H-Canyon as necessary to remove impurities that would interfere with the conversion-to-oxide process in HB-Line. The plutonium oxide will be placed in temporary storage until the capability is available to high fire the oxide and package it in accordance with the DOE storage standard.

Following a successful startup of HB-Line Phase II, H-Canyon plutonium solution stabilization began in January 2002 and is expected to be completed in December 2002.

The Department is also evaluating an alternate approach for stabilization (and disposition) of these solutions that is consistent with the recently announced decisions to proceed with construction, beginning in fiscal year 2004, of a mixed oxide (MOX) fuel fabrication facility and elimination of immobilization from the plutonium disposition pathway. The alternative being considered would be to transfer these solutions to HLW for vitrification in DWPF (in sludge batch 3), since the oxide produced from these solutions would not be suitable for use in MOX fuel. The Department expects to be in a position to make a decision regarding implementation of this alternative by June 2002. If a decision is made to pursue this alternate approach, these solutions would be transferred to HLW by the commitment date of December 2002 for completing conversion to oxide. Besides direct disposition of plutonium that could not be dispositioned as MOX fuel, transfer of these solutions to HLW would have the added benefit of reducing the amount of plutonium oxide requiring stabilization and packaging to meet DOE-STD-3013, thus accelerating completion of that activity.

Plutonium Metal and Oxide:

A capability at SRS to repackage plutonium to meet the metal and oxide storage standard will be established. Revision 1 of the 2000-1 IP discussed the project underway at that time to install equipment capable of high firing plutonium oxide and packaging plutonium metal and oxide in accordance with DOE-STD-3013 in existing building 235-F and contained related commitments.

Subsequent to issuance of Revision 1 of the 2000-1 IP, DOE continued to evaluate alternatives that might accelerate establishing the DOE-STD-3013 capabilities at SRS. As a result of these efforts, in June 2001 the Department canceled the 235-F Packaging and Stabilization Project and decided instead to implement a significantly less costly project to establish a 3013 capability within FB-Line. This alternate approach includes installation of new furnaces and an outer 3013 container welder in FB-Line, similar to the system used at Hanford, and use of radiography to perform a 100 percent inspection of the outer 3013 container welds.

While the SRS has established the capability to package plutonium metal into the inner 3013 container (using the FB-Line Bagless Transfer System), the greatest risk reduction for SRS plutonium storage will be achieved when plutonium oxides are packaged in accordance with DOE-STD-3013. Compared to the 235-F Project, the FB-Line approach will accelerate beginning the packaging of plutonium metal to meet the 3013 standard by up to three and a half years, beginning the stabilization and packaging of plutonium oxide to meet the 3013 standard by up to three years, and completing the stabilization and packaging of all plutonium by up to two and a half years.

To enable implementation of the new FB-Line project, DOE included in the October 19, 2001, ROD Amendment its decision to provide the capability for the stabilization and packaging of plutonium to meet DOE-STD-3013 within the FB-Line facility instead of within Building 235-F. Preliminary design for the FB-Line project has been completed, and procurement of the new furnaces and outer can welder (OCW) is proceeding. The baseline schedule shows startup of the OCW in April 2003, furnace startup in November 2003, and completion of all plutonium stabilization and packaging in accordance with DOE-STD-3013 in December 2005.

The Department is also evaluating an alternate approach for the stabilization (and disposition) of some plutonium oxides at SRS that, although able to be stabilized and packaged to meet DOE-STD-3013, are not suitable for use in MOX fuel due to impurities, such as enriched uranium. This alternative approach would involve dissolution of the material in H-Canyon or HB-Line to the separate impurities. The resulting plutonium solution would be converted to oxide usable in MOX fuel, and ultimately stabilized and packaged in accordance with DOE-STD-3013. This alternate approach would provide a disposition path for all materials in this category of oxides, and again result in the added benefit of reducing the amount of oxide requiring stabilization and packaging to meet DOE-STD-3013.

Rocky Flats Classified Plutonium Metal:

Subsequent to issuance of Revision 1 of the 2000-1 IP, it was determined that the classified plutonium metal that was shipped from Rocky Flats to SRS no longer requires declassification prior to packaging it to DOE-STD-3013. As a result, the associated recasting activities in FB-Line were terminated. This material will be packaged like all other on-site plutonium metal in accordance with DOE-STD-3013, and the storage records will contain the necessary historical information.

Residues:

For residues, the first 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 first IMNM EIS ROD also included the additional stabilization options of improving storage and vitrifying the materials in F-Canyon. The fourth Supplemental ROD issued October 31, 1997, added processing and storage for vitrification in the DWPF as another stabilization method.

The sand, slag and crucible, DU/Pu, and Mk-42 compacts have been dissolved in F-Canyon, and the plutonium sweepings have been dissolved using both F-Canyon and HB-Line Phase I. The resultant solutions in F-Canyon have been converted to metal in FB-Line and packaged in BTS containers. The resultant solution in HB-Line will be converted to oxide using HB-Line Phase II. The miscellaneous plutonium metal has been recast in FB-Line and packaged in BTS containers.

Where material and packaging properties are characterized incompletely, a program has been instituted to select the required stabilization process. Methods used include NDA using digital radiography equipment installed in March 1997, and selected sampling of containers using existing gloveboxes with modification. Full material characterization capability began in April 1999.

Current plans call for the repackaging of all existing high-grade, mixed plutonium solids (>100 g/can) to meet the metal and oxide storage standard. Other possibly unstable residues which are slated for processing include the mixed, low-grade solids. The material processed in HB-Line will be transformed to oxide. Ultimately, the plutonium oxides will be high fired and the plutonium metals and oxides will be packaged in accordance with DOE-STD-3013.

Rocky Flats Scrub Alloy:

In accordance with the first RFETS Residue EIS ROD (issued November 25, 1999), the existing scrub alloy at RFETS has been shipped to SRS where it was dissolved in F-Canyon. The plutonium recovered was processed through F-Canyon and transferred to FB-Line where it was converted to metal and packaged in BTS containers.

Spent Nuclear Fuel:

Based upon the IMNM EIS ROD (February 8, 1996), 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 containing HEU will be blended down and transferred to TVA, similar to the existing HEU solution and solutions resulting from dissolution of the Mk-16/22 spent fuel. The remainder will be transferred to the Waste Tank Farm.

DELIVERABLES/MILESTONES

Plutonium Solutions

- Commitment Statement: Complete conversion of pre-existing H-Canyon Pu-239 solution to oxide
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: H-Canyon and HB-Line
  Commitment Deliverable: 34,000 liters of H-Canyon Pu-239 solutions converted to oxide.
  Due Date: December 2002

Metal and Oxide >30% Plutonium

- Commitment Statement: Begin packaging plutonium metal into outer DOE-STD-3013 containers
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: FB-Line
  Commitment Deliverable: Begin operation of the outer can welder and placement of BTS containers into outer 3013 containers
  Due Date: April 2003

- Commitment Statement: Begin stabilization and packaging of plutonium oxide to DOE-STD-3013
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: FB-Line
  Commitment Deliverable: Begin operation of the new furnaces and high firing plutonium oxide
  Due Date: November 2003

Residues <30% Plutonium

- Commitment Statement: Begin converting SRS residue solution to oxide

Responsibility: Manager, Savannah River Operations Office
Applicable Facilities: HB-Line
Commitment Deliverable: Begin operation of HB-Line Phase II to convert solution from dissolution of pre-existing SRS plutonium residues to oxide
Due Date: January 2003

- Commitment Statement: Complete dissolution of SRS pre-existing plutonium residues
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: HB-Line, FB-Line and H-Canyon
  Commitment Deliverable: All SRS plutonium residues from May 1994 inventory dissolved
  Due Date: September 2005

- Commitment Statement: Complete stabilization and packaging of all plutonium at SRS to DOE-STD-3013
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: FB-Line
  Commitment Deliverable: All pre-existing SRS plutonium metal and oxide, and plutonium metal and oxide resulting from stabilization of all material within the April 2000 scope of the SRS stabilization program, stabilized and packaged in accordance with DOE-STD-3013
  Due Date: December 2005

Special Isotopes

- Commitment Statement: Complete transfer of Am/Cm solution to HLW
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: F-Canyon
  Commitment Deliverable: Complete transfer of Am/Cm solution from F-Canyon to the high level waste system
  Due Date: March 2003

- Commitment Statement: Begin stabilization of Np-237 solution
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: H-Canyon and HB-Line
  Commitment Deliverable: Begin converting May 1994 inventory of Np-237 solution to oxide
  Due Date: April 2005

- Commitment Statement: Complete stabilization of Np-237 solution
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: HB-Line and H-Canyon
  Commitment Deliverable: Np solution converted to stable oxide
  Due Date: December 2006

Uranium

- Commitment Statement: Begin disposition of pre-existing enriched uranium solution and enriched uranium solution resulting from Mk-16/22 SNF dissolution
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: H-Canyon, HA-Line
  Commitment Deliverable: Begin isotopic blend down of HEU solution and transfer of low enriched uranium solution to TVA
  Due Date: March 2003

- Commitment Statement: Complete disposition of pre-existing enriched uranium solution and enriched uranium solution resulting from Mark-16/22 SNF dissolution
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: H-Canyon, HA-Line
  Commitment Deliverable: All enriched uranium solutions transferred to TVA
  Due Date: September 2005

Spent Nuclear Fuel

- Commitment Statement: Complete Mark-16/22 SNF dissolution
  Responsibility: Manager, Savannah River Operations Office
  Applicable Facilities: H-Canyon
  Commitment Deliverable: Mark-16/22 SNF dissolved
  Due Date: March 2004

5.3 ROCKY FLATS

Plutonium Solutions:

Solutions remain in Building 559. Building 559 continues to generate small quantities of low-level waste solutions due to analytical analysis to support Site closure. These solutions are treated in Building 559 for disposal. 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 371, 771, 776/777 and 779. Tap and draining of Building 371 systems and processing of all Building 371 solutions were completed in June 1999. Draining from all 38 systems in Building 771 was completed in October 2001. Processing of all solution drained from B771 was completed in December 2001. Low-level solutions in Building 771, including holdup drained from piping systems and low-points, were batched in Building 771 and cemented in Building 774. Solutions from Building 771 and Building 559 activities that were compatible with the Caustic Waste Treatment System process were stabilized in Building 371. The precipitate was calcined and placed in temporary storage awaiting safe interim storage. The effluent was transferred to Building 374 and stabilized.

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 were controlled to prevent ignition sources. Tools, vacuum pumps, drain-taps and other equipment used on systems to be drained were 'non-spark' by design. Also, draining preparations include venting and purging operations that assured hydrogen in the piping was below the lower explosive limit.

Removal of piping systems continues in Building 771. As of May 2002, 37 of 38 systems have been removed. The two methods used to remove piping systems in Building 771 are a system-by-system (removal immediately after system has been drained) approach, and a recently added room-by-room approach. This new room-by-room approach (1) significantly increases worker industrial safety, (2) implements process efficiency lessons-learned from Building 779, and (3) reduces risk by accelerating draining of piping systems ahead of milestone schedules. The method that provides the greatest efficiency for risk reduction will be implemented. To minimize risk, each piping system is sampled to determine the system hydrogen generation rate. If the hydrogen concentration exceeds 25% of the lower explosive limit prior to pipe removal, the piping system will be removed immediately after draining (i.e., by implementing the system-by-system approach). The known leaking low points and joints are identified, contained, and controlled.

If hydrogen monitoring indicates that the piping system does not need to be removed immediately, the room-by-room approach is implemented. This method provides for partial removal of the process system to logical hold points or removal of the entire system. The piping may remain in place for up to 18 months after draining is completed. Prior to piping removal, the system is vacuum purged to ensure that any potential hydrogen is removed. The room-by-room approach minimizes the hazards associated with interference from other piping systems and improves industrial worker safety. Many piping systems are located several layers deep in the overheads that are located above gloveboxes and tanks. These piping systems are difficult to access; require intricate scaffolding to reach; and expose the workers to work in potentially unsafe conditions. The room-by-room approach allows piping to be removed from the bottom up, where piping is easily accessible without intricate scaffolding thereby substantially reducing fall, strain, and chemical exposure risk to the worker.

Both methods use characterization data gathered at the time of process system draining. If the room-by-room method is used, characterization data is saved and the piping left is tagged tying it back to the draining characterization data. This revised strategy supports site acceleration of process system draining and removal.

The liquid stabilization program will be integrated with current efforts to meet the appropriate safe storage criteria (i.e., DOE-STD-3013-2000 or Interim Safe Storage Criteria) for the plutonium solids generated as a result of the stabilization process. The solids generated will be initially packaged to meet site storage requirements until packaged to meet longer-term storage criteria. Figure 5.3-1 shows a simplified flow diagram.

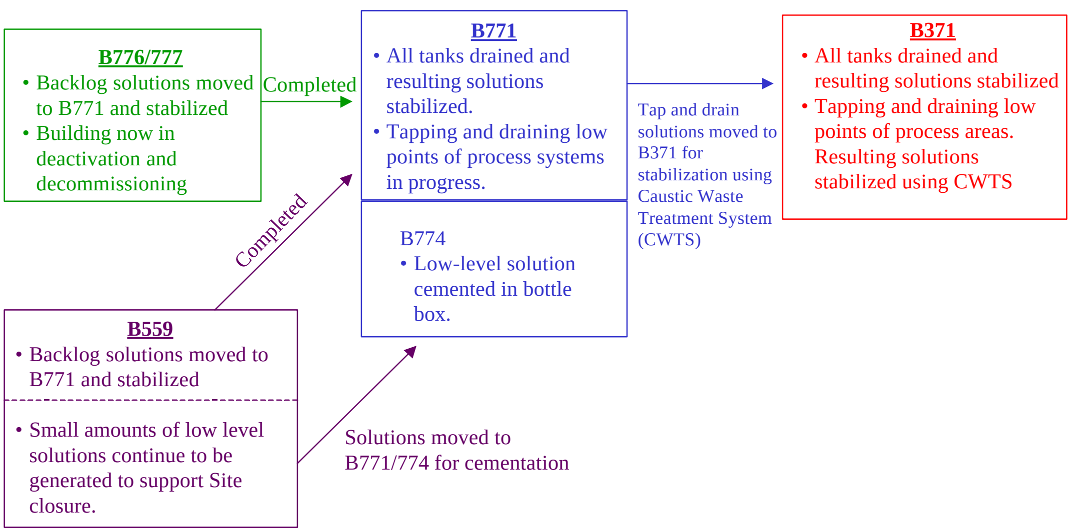


Figure 5.3-1: Plutonium Solution Stabilization Process Flow Diagram

<u>Metals and Oxides</u>: In order to meet DOE-STD-3013-2000, 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 weight percent moisture requirement, and package both metal and oxide in a welded stainless steel container, which is sealed within a second welded stainless steel container.

In the original 2000-1 IP (June 2000) it was projected that the Building 371 Plutonium Stabilization and Packaging System (PuSPS) would be available to start packaging metal or oxide into 3013 containers by October 2000. Due to construction delays, PuSPS startup commenced in June 2001. As a result of this delayed startup, along with higher than expected equipment failure rates which resulted in lower than anticipated production rates, the May 2002 commitment to complete repackaging all metal and oxides will not be met.

To hasten completion of the milestone, steps are being taken to minimize operational downtime as well as increasing operational schedules. Completion of all remaining metal and oxide repackaging is projected to be in January 2003.

The Department plans to accelerate the shipment of plutonium metal and oxides at Rocky Flats to SRS in order to support the goal of accelerating closure at Rocky Flats from 2010 to 2006. The K-Area Material Storage Facility at SRS has been modified to allow storage of Rocky Flats' plutonium pending disposition. The shipment of classified plutonium was completed in May 2001. This material will be processed for final disposition at SRS.

Scrub alloy, an alloyed button of plutonium and americium from the scrubbing of salts from the molten salt extraction process, has been 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 of RFETS scrub alloy were completed in March 2000. See Section 5.2.2 for when this material will be stabilized.

Residues:

Plans for remaining residues requiring stabilization are as follows:

Salts: Salt repackaging in a pipe component to meet ISSC and WIPP standards was completed in November 2000.

Wet Combustibles: Approximately 11,000 kilograms of wet combustible residues were originally classified as high risk. With the re-characterization of wet combustible residues from high hazard to low hazard, the need to perform any stabilization has been eliminated. Most of these low hazard wet combustible residues need only undergo a combination of sorting, blending, drying, repackaging, followed by gas generation testing, if necessary. A portion of these low hazard residues need only undergo real-time radiography and gas generation testing. Operations that implement this simplified repackaging strategy commenced on October 6, 1998. These residues when shipped to WIPP will meet all WIPP transport and disposal requirements, but the majority will not meet the ISSC double metal containment boundary requirement. All wet combustibles packaging was completed in May 2002. Rocky Flats will complete the shipment of wet combustibles to WIPP by June 2004.

Ash: Remaining 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. Ash repackaging was completed in February 2002.

Dry/Repack Residues: Dry/repack residues do not require stabilization but will be repackaged to meet the ISSC and WIPP transport and disposal requirements. Approximately 75 drums of dry/repack residues have been identified and characterized as containing light and heavy metal objects with plutonium surface contamination. These materials were improperly classified as residues and will be reclassified under the TRU Legacy Waste Program. The reclassification will allow these materials to be combined with similar wastes resulting in fewer drum shipments to WIPP. The remaining dry/repack residue repackaging operations were completed in May 2002.

Sand, Slag, and Crucible Residues: SS&C residues are currently being stored in a non-vented configuration. Surveillance will be performed until repackaging to WIPP standards commence. As required, any corrective actions to assure safe storage will be taken. SS&C residues will be blended, as required, to below the 10 weight percent plutonium concentration limit and placed in a pipe component to meet ISSC and WIPP standards. Repackaging operations for SS&C residues were completed in July 2001.

IP revisions have been made to reduce overall site risk and support site closure. All low risk residues (except wet combustible residues) have been repackaged to meet ISSC requirements in May 2002. Wet combustible residues have been repackaged to meet WIPP requirements in May 2002. Pending shipment to WIPP, a post-stabilization monitoring program for all residues will be implemented to assure safe interim storage.

DELIVERABLES/MILESTONES

Metal and Oxide

- Commitment Statement: Repackage all metal and oxides (except classified metal) into 3013 containers.
  Responsibility: Manager, Rocky Flats Field Office
  Applicable Facilities: Building 371
  Commitment Deliverable: Repackage all metal and oxides (except classified metal) into 3013 containers.
  Due Date: January 2003

Residues

- Commitment Statement: Complete repackaging all remaining low risk residues (except wet combustible residues) to meet ISSC. Wet combustible residues will be repackaged to meet WIPP requirements.
  Responsibility: Manager, Rocky Flats Field Office
  Applicable Facilities: Building 371
  Commitment Deliverable: Complete repackaging all remaining low-risk residues (wet combustible residues will be repackaged to meet WIPP requirements and other residues will be repackaged to meet ISSC requirements).
  Due Date: May 2002 - Completed

5.4 OAK RIDGE

The remaining material at Oak Ridge in the 2000-1 scope is plutonium stored at ORNL in Building 3027. Stabilization and removal of uranium materials at the Molten Salt Reactor Experiment at ORNL originally part of 94-1, is no longer being monitored by the DNFSB. Completion of this removal action will no longer be considered part of the 2000-1 program, but it is being tracked as an action under the Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA).

> *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 IP (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 plutonium (i.e., Pu-239, Pu-240, and Pu-241) identified as surplus -- are specifically 2000-1 materials. Of the surplus plutonium total, 520 grams is packaged and awaiting shipment to LLNL, ORNL is reviewing disposition options (including shipment to SRTC and/or disposal) for 167 grams, and ORNL has found programmatic uses for 21 grams.

It is Oak Ridge's intention that it will meet its one 2000-1 plutonium commitment to, "Repackage all plutonium metals and oxides to meet the metal and oxides storage standard," by May 2003, 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 the other 2000-1 material to LLNL where it will be integrated into and processed with that site's 2000-1 plutonium inventory. An agreement for shipping the material is currently being negotiated with LLNL.

The previous revision to this IP indicated that the ORNL plutonium in Building 3027 would be removed and stabilized by May 2002. This date will not be met due to the following delays:

> (1) identifying a funding source for transfer of material to LLNL,
> (2) responding to the impact of the events of September 11, 2001,
> (3) identifying material not suitable for LLNL processsing due to high radiation doses, and (4) deferring the programmatic uses at LANL by the Pu-238 Heat Source Program.

The ORNL is taking several steps to remedy these delays in order to meet the May 2003 commitment date. Specifically, ORNL has allotted FY 2002 funding for transferring material to LLNL, ORNL is reviewing disposition options for plutonium that must be remotely handed due to high dose rates, and ORNL is in the preliminary planning stages of transferring Pu-238 programmatic material to LANL.

DELIVERABLES/MILESTONES

Metal and Oxide >30% Plutonium

- Commitment Statement: Repackage all plutonium metals and oxides to meet the metal and oxide storage standard.

  Responsibility: G. Malosh, Site Manager, Oak Ridge National Laboratory
  Applicable Facilities: ORNL, Building 3027
  Commitment Deliverable: Dispose of unneeded plutonium at ORNL.
  Due Date: May 2003

5.5 LOS ALAMOS NATIONAL LABORATORY

Table 5-1 shows the inventory stabilization schedule for the 5248 items in LANL inventory (3689 excess items that comprise the 94-1 scope plus the 1559 programmatic items). The schedule indicates that the entire inventory of 5248 items will be stabilized and repackaged by CY2010. Completion of 94-1 items may occur earlier than the overall stabilization schedule presented in Table 5-1 depending on the approval of vulnerability assessment for discard of some matrices as well as on the implementation of processing and personnel efficiencies. In June 2001, 1559 items were identified to be of programmatic use and were included in the development of the overall resource loaded schedule as an integrated approach for inventory and risk management at LANL. These items will be stabilized and repackaged in parallel with 94-1 items with a projected completion date of CY2010.

The annual stabilization progress for LANL will be measured against Table 5-1.

Table 5-1: LANL Inventory Stabilization Schedule

Inventory in Non-Standard Cans	Total Items	2002	2003	2004	2005	2006	2007	2008	2009	2010
Vessels	9	0	0	3	3	3	0	0	0	0
Roasting and Blending	950	100	125	150	150	150	150	125	0	0
Exp. Reduction Line	1073	0	0	0	0	0	280	280	280	233
Nitrate Operations	398	40	45	45	45	45	45	45	45	43
Chloride Operations	1143	100	130	130	130	130	130	130	130	133
Unique Items	116	19	20	20	20	20	17	0	0	0
Programmatic Repackaging	1559	100	100	125	280	280	280	210	91	93
TOTAL	5248	359	420	473	628	628	902	790	546	502

The inventory has been divided into seven general categories depending on the potential disposition path. The first category is the unsheltered vessels. The second category represents a minimal processing category that has significant potential for dispersion should there be a complete failure of a container. These are oxides and other materials that can be thermally treated and placed in welded containers. The third major category is of materials that will require use of the exposure reduction line due to high exposures associated with these materials. The fourth and fifth categories are residues that can be handled through the existing nitrate and chloride processing lines. The sixth is items that are primarily non-Pu239 matrices, and the final category consists of the programmatic items throughout

LANL that may need to be repackaged to meet the interim safe storage criteria.

Unsheltered Containers:

There are nine six-foot diameter spherical storage vessels sited in TA-55 yard area which contain SNM. These large metal vessels are cleaned out by mating their portals up to a glovebox line and emptying their contents into the line. The SNM-containing items are physically sorted and size reduced and then evaluated for disposition. The SNM-containing item endpoints are either WIPP-WAC certified containers or 3013-specification welded containers.

The process schedule for treating these vessels is provided in Table 5-1. With the current configuration of equipment at TA-55, it is not possible to deal with more than one of these vessels at a time in a given year. Therefore, the most probable path for these items will be to introduce them into Chemical Metallurgical Research (CMR) facility, remove the contents, package these consistent with the vault storage requirements, and evaluate which of these "newly" produced items can be directly discarded and which require additional processing. Obtaining the approval to process these items at CMR is dependent on the attractiveness level of SNM in each item; CMR is presently a Cat III facility. The decision to move forward with processing these items at CMR will be made in FY02. The vessels will be processed at a rate of three per year beginning in CY04 and are projected for completion by CY06.

Metal and Oxide:

Roasting and Blending Operations:

There are several categories that may be candidates for stabilization, blending and canning into 3013 containers to meet long-term storage requirements. These items and their completion dates are listed in the following table:

IP Description	Item Description	Item Count	Year Complete
Metal/Oxide-like	Dioxide	186	2003
Miscellaneous Items	Dioxide - MT 51,52,53	25	2003
Metal/Oxide-like	Sweepings/Screenings	216	2005
Miscellaneous Items	Sweepings- MT 52	45	2005
Metal/Oxide-like	Filter Residue	214	2007
Metal/Oxide-like	Incinerator Ash, MT 52	81	2007
Residue	Hydroxide Precipitate	61	2008
Metal/Oxide-like	Alloyed Metal, MT 52	14	2008
Metal/Oxide-like	Unalloyed Metal	98	2008
Miscellaneous Items	Unalloyed Metal-MT52,53	7	2008
Residue	Sulfate/Oxalate ppt.	3	2008
TOTAL		950	

The roasting and blending operations include burning, brushing, screening, blending and roasting of plutonium metals, oxides and oxide-like materials. The excess oxides from roasting and blending are welded into 3013-specification storage containers. Standard feeds are plutonium oxides, metals and oxide-like items of material type 53 (meaning 8.45% Pu-240) or less and have radiation exposures less than 100 millirem/hour. The current glovebox is setup to handle standard items which have radiation exposures that are less than 100 millirem per hour.

Exposure Reduction Line Operations:

These operations include burning, brushing, screening, blending and roasting of plutonium metals, oxides and oxide-like items that are not suitable for handling in the standard Roasting and Blending area due to high radiation exposures. This work is performed in a glovebox line, known as the Exposure Reduction Line, that is fitted with manipulators to allow remote handling. The excess oxides from this process are welded into 3013-specification storage containers. Non-standard feeds include SNM other than plutonium, multiple material type items, plutonium oxides of Material Type 54 (meaning 11% 240Pu) or higher, and items with radiation exposures greater than100 millirem/hour. These items and their completion dates are provided in the following table:

IP Description	Item Description	Item Count	Year Complete
Metal/Oxide-like	Dioxide - High Exposure	382	2008
Miscellaneous Items	Dioxide - non Pu or MT54	138	2009
Metal/Oxide-like	Sweepings/Screenings	31	2009
Miscellaneous Items	Sweepings-MT54-57, non Pu	32	2009
Salts and MgO	MSE Salt	285	2010
Metal/Oxide-like	Filter Residue - High Exp.	42	2010
Metal/Oxide-like	Incinerator Ash- High Exp.	33	2010
Residue	Hydroxide ppt. - High Exp.	11	2010
Metal/Oxide-like	Alloyed Metal- High Exp.	60	2010
Metal/Oxide-like	Unalloyed Metal- High Exp	33	2010
Residue	Sulfate/Ca Metal, Fluoride, tetrafluoride	26	2010
TOTAL		1073	

Standard feed items are defined as items that can be processed in the same line as the pit rebuild line. Items such as MSE salts, incinerator ash, hydroxide precipitate, etc., will be discarded once the vulnerability assessment is approved for discard.

Nitrate Operations:

There are 398 items that may require processing through the lean nitrate operation lines. The operations consist of nitric acid dissolution, leaching, anion exchange, oxalate precipitation, hydroxide precipitation, evaporation, nitric acid recycle and crushing and pulverizing. Standard feeds are plutonium-containing materials that do not contain chlorides, are material types of 53 (meaning average 8.45 % 240Pu) or lower, and have radiation exposures lower than 100 millirem per hour. These include items such as impure plutonium oxides, non-chloride salts, sand slags, crucibles, leaded gloves, plastics, tools, non-actinide metals, glass, graphite, etc. The non-standard feeds include non-chloride containing materials that contain SNM other than plutonium, multiple material types, material types of 54 (meaning 11% 240Pu) or higher, or items that have radiation exposures higher than 100 millirem per hour. These include items such as impure SNM oxides, non-chloride salts, sand slags, crucibles, leaded gloves, plastics, tools, non-actinide metals, glass, cellulose rags, tetrafluorides, silica, resins, etc. The nitrate support operations also include a discard evaluation team, vitrification, cementation, and WIPP-WAC packaging operations. The resultant plutonium oxides are packaged in standard storage containers awaiting processing to make them suitable for 3013-specification container packaging or WIPP-WAC.

The item descriptions and their completion dates are provided in the following table:

IP Description	Item Description	Item Count	Year Complete
Miscellaneous Item	Nitrate Solution-MT 52	1	2002
Residue	Graphite - multiple MT's	62	2003
Residue	Non-actinide Metal, Glass, Fire Brick	243	2008
	HEPA Filters	18	2009
Residue	Plastic/Kim Wipes, Heating Mantles, Asbestos, Leaded Gloves, Rubber, Filter Media, Paper/Wood, Noncombustib.	74	2010
TOTAL		398	

Chloride Operations:

There are 1143 items that may be suitable for chloride-based processing. These operations consist of dissolution, leaching, recovery, purification by anion exchange or solvent extraction, oxalate precipitation, hydroxide precipitation, followed by calcination of SNM-containing residues in hydrochloric acid. Typical residues processed include impure plutonium metals, alloys, ER, DOR, miscellaneous salts, oxides and crucible pieces with radiation exposures less than 100 millirem per hour. The resultant oxides are packaged in a TA-55 site standard package to be roasted and blended and packaged into a 3013 at a later date or to a WIPP-WAC package depending on the minimum consequence path. The material feeds and their completion dates are provided in the following table:

IP Description	Item Description	Item Count	Year Complete
Salts and MgO	DOR Salt, ER	598	2008
Salts and MgO	Calcium Salt, Chloride	20	2009
Residue	CaO, Al oxide, trichloride	4	2010
Salts and MgO	Misc. Salt, Hydrogenous Salt, Misc. Salt-MT 52	129	2010
Salts and MgO	MgO	392	2010
TOTAL		1143	

Unique Item Disposition:

There are a total of 116 items that are a mixture of actinides. Included in these items are matrices containing primarily HEU, matrices with neptunium, americium, curium, or mixtures of all of these, and items containing Pu-238. Many of these items will be directly discarded once the vulnerability assessment is approved. For those that cannot be directly discarded, the unique item disposition team will process these in isolated gloveboxes to avoid contaminating pit rebuild process lines with these highly undesirable isotopes. The completion dates for disposition of the items that fall in this category are shown below:

IP Description	Item Description	Item Count	Year Complete
Residue	Cellulose Rags	10	2002
Solutions	Organic solution	5	2002
Residue	Resin, Resin - MT 82	4	2002
Miscellaneous Items	Trioxide-MT72, Misc. salt-MT 38, tetrafluoride-MT72	4	2003
Miscellaneous Items	Alloyed Metal-MT57, non Pu	30	2004
Miscellaneous Items	Unalloyed metal-non Pu, Nonactinide metal-MT72	46	2006
Residue/Misc. Items	Carbide, Nitrate-MT72, U3O8	17	2007
TOTAL		116	

Programmatic Repackaging:

The programmatic items in the TA-55 storage vault and CMR Facility are in storage configurations which may not meet the Interim Packaging Criteria for these facilities. These items will be visually inspected and evaluated for container packaging configuration and continued programmatic use. The items will be processed as required and repackaged to meet the Interim Safe Storage Criteria.

Description	Item Count	Year Complete
TA-55 Repackaging	1255	2008
CMR Repackaging	151	2009
Other LANL Site Repackaging	153	2010
TOTAL	1559	

There are programmatic items that currently reside at TA-18, TA-35, TA-48, TA-53, TA-21, and TA-54 which may need to be inspected and repackaged to meet the Interim Criteria.

DELIVERABLES/MILESTONES

Solutions

- Commitment Statement: Complete stabilization of all solutions
  Applicable Facilities: TA-55
  Commitment Deliverable: Stabilize remaining 4 organic solutions
  Due Date: December 2002

Residues

- Commitment Statement: Complete stabilization of nitrides and cellulose rags
  Applicable Facilities: TA-55
  Commitment Deliverable: Stabilize remaining 3 rag items and 1 nitride item
  Due Date: December 2002

- Commitment Statement: Complete stabilization of the remaining residues
  Applicable Facilities: TA-55
  Commitment Deliverable: Stabilize all remaining residues
  Due Date: December 2010

Oxides < 100 mrem/hr

- Commitment Statement: Complete roasting and blending of oxide items
  Applicable Facilities: TA-55
  Commitment Deliverable: Roast and blend all dioxide items
  Due Date: December 2003

Unsheltered Containers

- Commitment Statement: Resume processing containers in FY’04
  Commitment Deliverable: Empty the contents of each container for characterization and subsequent stabilization or discard.
  Due Date: December 2006

Unique Items

- Commitment Statement: Complete disposition of all mixed items
  Commitment Deliverable: Discard and/or stabilize 116 unique items
  Due Date: December 2007

Metal and Oxide-like Items, < 100 mrem/hr

- Commitment Statement: Complete stabilization and packaging of metal and oxide-like items
  Applicable Facilities: TA-55
  Commitment Deliverable: Roast, blend and package metals and oxide-like items to 3013
  Due Date: December 2008

Programmatic Items

- Commitment Statement: Complete repackage of programmatic items
  Applicable Facilities: TA-55, TA-18, CMR, TA-54, TA-35
  Commitment Deliverable: Inspect, repackage 1559 items to meet interim storage criteria
  Due Date: December 2010

5.6 LAWRENCE LIVERMORE NATIONAL LABORATORY

LLNL has procured, installed, and made operational the Plutonium Packaging System (PuPS) in order to package its excess 94-1 plutonium inventory (summarized in Chapter 4) to meet DOE-STD-3013-2000 requirements. LLNL is using existing gloveboxes and furnaces to meet stabilization requirements. Although these gloveboxes and furnaces had been previously installed for another program, the gloveboxes were never closed and approved for plutonium operations. The PuPS was approved by DOE-OAK for operation with plutonium on February 1, 2001. The whole batch (i.e., a 3013 can volume) calcining and loss on ignition (LOI) glovebox was approved for plutonium operations on January 4, 2002. The oxide washer was approved for operations with plutonium on November 15, 2001.

Metal and Oxide Materials > 30% Pu + U. The oxides will be thermally stabilized and packaged in accordance with DOE-STD-3013-2000 by December 2003. The metal will have non-adherent oxide removed and the metal will be packaged in accordance with DOE-STD-3013-2000 by December 2003. The 115 cans of this material are planned to be shipped to SRS for storage and disposition.

Residues < 30 wt% Pu + U. Some of the low grade oxide will be washed with water to remove solubles and then thermally stabilized by calcination prior to packaging. Resultant materials that meet the DOE-STD-3013-2000 standard will be packaged accordingly. The resultant material that meets WIPP acceptance criteria will be shipped to WIPP for disposal as TRU waste. The remainder will be retained on site until a decision for further disposition is made.

The original scheduled completion date of May 2002 for these commitments will be missed due to the following reasons:

(1) the addition of uranium and plutonium legacy items to the LLNL “94-1" inventory ;
(2) the revised SRS acceptance criteria requiring LLNL to conduct 100% radiography (instead of sampling) of the sealed 3013 containers prior to shipment;
(3) the degree of effort required to wash and calcine the plutonium oxide and residues; and
(4) diversion of LLNL resources to meet additional safety and security requirements following the events of September 11, 2001.

As shown below, the revised completion date is December 2003 for the commitments to stabilize and package metals, oxides, and residues.

DELIVERABLES/MILESTONES

Metal and Oxide >30% Plutonium + Uranium

- Commitment Statement: Complete plutonium metal and oxide repackaging.
  Responsibility: Manager, Oakland Operations Office
  Applicable Facilities: LLNL Building 332
  Commitment Deliverable: Complete plutonium metal and oxide repackaging.
  Due Date: December 2003

Residue <30% Plutonium + Uranium

- Commitment Statement: Stabilize and package LLNL ash residues.
  Responsibility: Manager, Oakland Operations Office
  Applicable Facilities: LLNL Building 332
  Commitment Deliverable: Stabilize and package all other LLNL residues.
  Due Date: December 2003

6.0 NUCLEAR MATERIAL ENDSTATE OF THIS PLAN

The activities of Chapter 5 create a safe configuration of nuclear materials that are either in use, in forms for interim storage, or, for discarded items, in forms that can be responsibly managed as waste. This endstate is more specifically defined as follows:

- All items to be reclaimed for programmatic uses are sent to the facilities where those uses (and material management activities) will occur.
- All 94-1 plutonium metal and oxide is packaged according to the long-term storage standard, DOE-STD-3013-2000.
- 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 to be dispositioned as transuranic (TRU) waste are packaged in accordance with either the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria or with site TRU waste operational requirements for safe on-site storage and management.
- All other 94-1 low-assay materials are packaged in accordance with either the Interim Safe Storage Criteria (ISSC) or the long-term storage standard, DOE-STD-3013-2000.

To amplify on the first bullet, it is beyond the purview of this plan to govern (a) the management of material in programmatic use, and (b) the follow-on material dispositioning activities. The duration of these uses (and reuses) is not now known, and therefore this plan is not an effective management tool to capture the future material dispositioning activities that will take place at the end of those uses. Other Departmental requirements (e.g., for occupational radiation protection) and management responsibilities (e.g., in program and site management) apply to those future activities.

To amplify on the next-to-last bullet, items to be discarded as waste will be transitioned to site waste operations for responsible on-site storage and management and eventual shipment to a disposal facility. Such items would, as part of site waste inventories, be subject to the site waste management system of requirements and operational practices that are devised to ensure safety. Therefore, continued tracking of those items in this plan would be unnecessarily duplicative with a site’s waste management system.

For the purposes of this IP, the Department defines closure of the actions related to Recommendation 2000-1 as the achievement of this endstate.

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 Assessment (EA)—A concise public document that a Federal agency prepares under the National Environmental Policy Act (NEPA) to provide sufficient evidence and analysis to determine whether a proposed agency action would require preparation of an environmental impact statement (EIS) or a finding of no significant impact. A Federal agency may also prepare an EA to aid its compliance with NEPA when no EIS is necessary or to facilitate preparation of an EIS when one is necessary.

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 decisonmaking, it describes the potential impacts of the proposed and all reasonable 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, lead-impregnated 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 decisionmaking 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.

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 Storage 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
DP	Office of Defense Programs
DWPF	Defense Waste Processing Facility
EBR	Experimental Breeder Reactor
EIS	Environmental Impact Statement
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
INEEL	Idaho Engineering and Environmental Laboratory
IPABS	Integrated Planning, Accountability and Budgeting System
IPM	Implementation Plan Manager
IPMP	Integrated Project Management Plan
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
ISSC	Interim Safe Storage Criteria
LANL	Los Alamos National Laboratory
LEU	Low-enriched Uranium
LFL	Lower Flammability Limit
LLNL	Lawrence Livermore National Laboratory
LOI	Loss On Ignition
m^3	Cubic Meters
MCO	Multi-canister Overpacks
MOI	Maximally exposed off-site individual
MOX	Mixed Oxide
MPPF	Multi-Purpose Processing Facility
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
NNSA	National Nuclear Security Administration
OCW	Outer Can Welder
ORNL	Oak Ridge National Laboratory
PDM	Plutonium Disposition Methodology
PFP	Plutonium Finishing Plant
PFP EIS	Plutonium Finishing Plant Stabilization Final Environment Impact Statement
PIP	Plutonium Immobilization Plant
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
TGA	Thermo-Gravimetric Analysis
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

U. S. Department of Energy, *A Risk-Based Prioritization Methodology of Legacy Fissile Material Disposition at LANL*, LA-UR-00-5111.

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

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.

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

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, October, 1995.

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, *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.

Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials, November 1995, issued via a January 25, 1996 letter from Deputy Secretary of Energy Charles Curtis as an addendum to the 94-1 Implementation Plan of 1995.

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

A Surveillance Program to Assure Safe Storage of FB-Line and Building 235F Vault Materials, WSRC-TR-96-0413, December 30, 1996

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

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.

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

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

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

U. S. Department of Energy, *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, August 1998.

U.S. Department of Energy, *Stabilization, Packaging, and Storage of Plutonium Bearing Materials*, DOE-STD-3013-99, Office of Environmental Management, 1999.

U. S. Department of Energy, *Surplus Plutonium Disposition Final Environmental Impact Statement*, Office of Fissile Materials Disposition, November 1999.

Defense Nuclear Facilities Safety Board letter from John T. Conway to Bill Richardson, dated January 14, 2000, regarding concerns with the progress of the implementation of Recommendation 94-1, and approval of Recommendation 2000-1.

Defense Nuclear Facilities Safety Board Recommendation 2000-1 to the Secretary of Energy pursuant to 42 U.S.C. § 2286a(a)(5), Atomic Energy Act of 1954, as amended, dated January 14, 2000.

U. S. Department of Energy letter from Bill Richardson to John T. Conway, dated March 13, 2000, acknowledging receipt of Recommendation 2000-1.

Savannah River Site Stabilization and Packaging Requirements for Plutonium Bearing Materials for Storage, G-ESR-G-00035, Revision 1, July 26, 2000.

U.S. Department of Energy, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials*, DOE-STD-3013-2000, September 2000.

U. S. Department of Energy letter from Bill Richardson to John T. Conway, dated January 19, 2001, providing Revision 1 of the 2000-1 Implementation Plan.

Interface with the Defense Nuclear Facilities Safety Board, Department of Energy Manual DOE M 140.1-1B, 2001.

Defense Nuclear Facilities Safety Board letter from John T. Conway to Spencer Abraham, dated March 23, 2001, requiring modifications on the revised Implementation Plan 2000-1. It establishes a 60-day reporting requirement identifying the items stated in the Defense Nuclear Facilities Safety Board letter.

Defense Nuclear Facilities Safety Board letter from John T. Conway to Carolyn L. Huntoon, dated May 3, 2001, regarding the stabilization and repackaging of nonprogrammatic plutonium metal and oxide in accordance with DOE-STD-3013, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials.*

Defense Nuclear Facilities Safety Board letter to from John T. Conway to Carolyn L. Huntoon, dated May 29, 2001, regarding stabilization of about 14,000 liters of americium and curium (Am/Cm) solution in F-Canyon at the Savannah River Site.

U. S. Department of Energy letter from Spencer Abraham to John T. Conway, dated June 12, 2001, responding to the Defense Nuclear Facilities Safety Board letter dated March 23, 2001, regarding Implementation Plan 2000-1, Revision 1.

U. S. Department of Energy letter from Spencer Abraham to John T. Conway, dated August 8, 2001, approving a proposed limited change to the 2000-1 Implementation Plan commitment concerning packaging of wet combustible residues at Rocky Flats.

U. S. Department of Energy memo from Greg Rudy to the Assistant Secretary for Environmental Management, dated September 6, 2001, subject, “Energy Systems Acquisition Advisory Board action to approve the cancellation of the Savannah River Site Americium/Curium (Am/Cm) Vitrification Project S-5997.”

U. S. Department of Energy letter from Spencer Abraham to John T. Conway, dated September 19, 2001, providing additional information relative to the Defense Nuclear Facilities Safety Board letter dated March 23, 2001, regarding Implementation Plan 2000-1.

Defense Nuclear Facilities Safety Board letter from John T. Conway to Spencer Abraham, dated November 21, 2001, regarding suggestions on the revised Implementation Plan for 94-1 and 2000-1.

U. S. Department of Energy Headquarters Press Release No. PR-02-007, dated January 23, 2002, subject, “Secretary Abraham Announces Administration Plan to Proceed with Plutonium Disposition & Reduce Proliferation Concerns.”

U. S. Department of Energy letter from David G. Huizenga to John T. Conway, dated February 14, 2002, regarding revisions in the 2000-1 Implementation Plan.

Defense Nuclear Facilities Safety Board letter from John T. Conway to Jessie Hill Roberson, dated February 15, 2002, regarding the removal and safe interim storage of spent nuclear fuel stored in the Hanford K-East Basin.

U. S. Department of Energy letter from C. Anson Franklin to the Honorable Pete Domenici, dated March 5, 2002, regarding the disposal of 34 metric tons of surplus plutonium by turning the material into mixed oxide (MOX) fuel for use in commercial nuclear reactors.

U. S. Department of Energy memo from Henry F. Dalton to Mark Frei, dated April 1, 2002, subject, "High Priority of Wet Combustible Residue Shipments."

S. Boerigter, 2001. *A Risk-Based Prioritization Methodology for Legacy Fissile Material Disposition at LANL*, LA-UR-00-5111, October 2001.

H. Jordan, 2002. *Formalized Dose Risk from Excess Inventory at TA-55*, LA-CP-01-506, April 2002.

APPENDIX D
SUMMARY OF COMMITMENTS

The individual commitments described in Chapter 5 are listed below. The numbering convention is that commitments numbered in the 100's correspond to the Hanford Site, 200's correspond to Savannah River, 300's correspond to Rocky Flats, 400's correspond to Oak Ridge, 500's correspond to LANL, and 600's correspond to LLNL.

HANFORD PLUTONIUM FINISHING PLANT

Plutonium Solutions

- *Commitment Statement:* Complete stabilizing and packaging plutonium solutions.
  IP Commitment Number: 106
  Due Date: July 2002[1]

Plutonium Metals

- *Commitment Statement:* Resolve weld porosity issues associated with metals.
  IP Commitment Number: 110
  Due Date: December 2002[2]

Plutonium Oxide and Mixed Oxides

- *Commitment Statement:* Complete disposition of oxides.
  IP Commitment Number: 111
  Due Date: May 2004

Plutonium Alloys

- *Commitment Statement:* Package remaining alloys to meet DOE-STD-3013 criteria.
  IP Commitment Number: 114
  Due Date: December 2002[3]

Polycubes

- *Commitment Statement:* Complete stabilization and packaging of polycubes.
  IP Commitment Number: 115
  Due Date: March 2003[4]

Residues

- *Commitment Statement:* Complete stabilization and packaging of residues.
  IP Commitment Number: 116

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[1]Previous revision due date: December 2001

[2]Previous revision due date: August 2001

[3]Previous revision due date: June 2001

[4]Previous revision due date: August 2002

Due Date: April 2004

HANFORD K-BASINS

Spent Nuclear Fuel

- *Commitment Statement:* Complete removal of 957.115 metric tons heavy metal (MTHM) from the K-West Basin to the Cold Vacuum Drying Facility.
  IP Commitment Number: 118W
  Due Date: December 2002

- *Commitment Statement:* Begin fuel removal from the K-East Basin and transport to K West Basin.
  IP Commitment Number: 117E
  Due Date: November 2002[5]

- *Commitment Statement:* Complete fuel removal from both the K West Basin and the K East Basin to the Cold Vacuum Drying Facility.
  IP Commitment Number: 118E
  Due Date: July 2004

- *Commitment Statement:* Begin K-Basin sludge removal.
  IP Commitment Number: 119
  Due Date: December 2002

- *Commitment Statement:* Complete K-Basin sludge removal.
  IP Commitment Number: 120
  Due Date: August 2004

SAVANNAH RIVER

Plutonium Solutions

- *Commitment Statement:* Complete converting pre-existing H-Canyon Pu-239 solution to oxide.
  IP Commitment Number: 202
  Due Date: December 2002

Metals and Oxide >30% Pu

- *Commitment Statement:* Begin packaging plutonium metal into outer DOE-STD-3013 containers
  IP Commitment Number: 207[6]
  Due Date: April 2003

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[5]Previous revision due date: December 2002

[6] This is a newly assigned tracking number not shown in the previous revision to this IP.

- *Commitment Statement:* Begin stabilization and packaging of plutonium oxide to DOE-STD-3013
  IP Commitment Number: 208[7]
  Due Date: November 2003

Residues <30% Pu

- *Commitment Statement:* Begin converting SRS residue solution to oxide.
  IP Commitment Number: 210
  Due Date: January 2003

- *Commitment Statement:* Complete dissolution of SRS pre-existing plutonium residues.
  IP Commitment Number: 211
  Due Date: September 2005

Metals, Oxides, and Residues

- *Commitment Statement:* Complete stabilization and packaging of all plutonium at SRS to DOE-STD-3013.
  IP Commitment Number: 212
  Due Date: December 2005[8]

Special Isotopes

- *Commitment Statement:* Complete transfer of Am/Cm solution to HLW
  IP Commitment Number: 213[9]
  Due Date: March 2003

- *Commitment Statement:* Begin stabilization of pre-existing Np-237 solution.
  IP Commitment Number: 219
  Due Date: April 2005

- *Commitment Statement:* Complete stabilization of pre-existing Np-237 solution.
  IP Commitment Number: 220
  Due Date: December 2006

Uranium

- *Commitment Statement:* Begin disposition of pre-existing enriched uranium solution and enriched uranium solution resulting from Mk-16/22 SNF dissolution.
  IP Commitment Number: 224
  Due Date: March 2003

- *Commitment Statement:* Complete disposition of pre-existing enriched uranium solution and enriched uranium solution resulting from Mk-16/22 SNF dissolution.
  IP Commitment Number: 225

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[7] This is a newly assigned tracking number not shown in the previous revision to this IP.

[8] Previous revision due date: June 2006 - June 2008

[9] This is a newly assigned tracking number not shown in the previous revision to this IP.

Due Date: September 2005

Spent Nuclear Fuel

- *Commitment Statement:* Complete Mark-16/22 SNF dissolution.
  IP Commitment Number: 227
  Due Date: March 2004

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Metal and Oxide >30% Pu

- *Commitment Statement:* Repackage all metal and oxides (except classified metal) into 3013 containers by January 2003.
  IP Commitment Number: 305
  Due Date: January 2003[10]

Residues <30% Pu

- *Commitment Statement:* Complete repackaging all remaining low risk residues (except wet combustible residues) to meet ISSC. Wet combustible residues will be repackaged to meet WIPP requirements.
  IP Commitment Number: 308
  Due Date: May 2002 - Completed

OAK RIDGE

Metal and Oxide >30% Pu

- *Commitment Statement:* Repackage all plutonium metals and oxides to meet the metal and oxide storage standard.
  IP Commitment Number: 401
  Due Date: May 2003[11]

LOS ALAMOS NATIONAL LABORATORY

Solutions

- *Commitment Statement:* Complete stabilization of all solutions
  IP Commitment Number: 501

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[10]Previous revision due date: May 2002

[11]Previous revision due date: May 2002

Due Date: December 2002[12]

Residues

- *Commitment Statement*: Complete stabilization of nitrides and cellulose rags
  IP Commitment Number: 503
  Due Date: December 2002[13]

- *Commitment Statement*: Complete stabilization of the remaining residues
  IP Commitment Number: 504
  Due Date: December 2010[14]

Oxides < 100 mrem/hr

- *Commitment Statement*: Complete roasting and blending of oxide items
  IP Commitment Number: 506[15]
  Due Date: December 2003

Unsheltered Containers

- *Commitment Statement*: Process these containers by characterization of their contents, followed by stabilization or discard.
  IP Commitment Number: 505
  Due Date: December 2006[16]

Unique Items

- *Commitment Statement*: Complete disposition of all mixed items
  IP Commitment Number: 507[17]
  Due Date: December 2007

Metal and Oxide-like Items, < 100 mrem/hr

- *Commitment Statement*: Complete stabilization and packaging of metal and oxide-like items
  IP Commitment Number: 502

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[12]Previous revision due date: October 2001

[13]Previous revision due date: October 2001

[14]Previous revision due date: October 2010

[15]This is a newly assigned tracking number not shown in the previous revision to this IP.

[16]Previous revision due date: October 2010

[17]This is a newly assigned tracking number not shown in the previous revision to this IP.

Due Date: December 2008[18]

Programmatic Items

- *Commitment Statement*: Complete repackage of programmatic items to meet interim storage criteria.
  IP Commitment Number: 508[19]
  Due Date: December 2010

LAWRENCE LIVERMORE NATIONAL LABORATORY

Metal and Oxide >30% Plutonium + Uranium

- *Commitment Statement:* Complete plutonium metal and oxide packaging by May 2003
  IP Commitment Number: 601
  Due Date: December 2003[20]

Residue <30% Plutonium + Uranium

- *Commitment Statement:* Stabilize and package all other LLNL residues by May 2003.
  IP Commitment Number: 603[21]
  Due Date: December 2003[22]

[18]Previous revision due date: October 2004

[19]This is a newly assigned tracking number not shown in the previous revision to this IP.

[20]Previous revision due date: May 2002

[21]The previous revision to this IP listed this commitment as two separate actions (numbered 602 and 603) both due May 2002.

[22]Previous revision due date: May 2002

APPENDIX E
SUMMARY OF THE 94-1 INVENTORY

Summarized below are the inventories of nuclear materials requiring stabilization in the Departmental commitments of this IP.

E.1 Plutonium Solutions

Approximately 412,000 liters of Pu-239 solutions existed throughout the DOE complex, primarily at Rocky Flats, SRS, 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. More than 90% of those solutions have been stabilized, and only approximately 37,000 liters still require stabilization.

Table E.1 compares the plutonium solutions inventories at the three major sites. The tabulated information includes quantities existing at the time the original Recommendation 94-1 IP was promulgated and changes in the inventories that have occurred since then. Note that changes in total quantities to be stabilized at Rocky Flats and Hanford reflect improved inventory estimates.

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 a Savannah River canyon, to the development of additional processes such as Magnesium Hydroxide precipitation at Hanford's Plutonium Finishing Plant.

Table E.1: Plutonium (Pu-239) Solutions Inventory Summary

Site	Original Quantity (L)	Original Location	Adjusted Inventory (L)	Remaining to be Stabilized (L) as of 3/02	Current Location
Rocky Flats	30,000	Bldgs 371, 559, 771, 776/777, 779	30,000	0 ‡	–
Savannah River	320,000	F-Canyon	--*	0	--
Savannah River	34,000	H-Canyon	34,000	34,000	H-Canyon
Hanford	4,800	Plutonium Finishing Plant	4,690,** later revised to 4,270	2,670	PFP
Hanford	22,700	PUREX	–***	0	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 was roughly an order of magnitude less than originally estimated.

E.2 Plutonium Metals and Oxides

The DOE currently manages large quantities of plutonium metal and oxide. 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 E.2a and E.2b respectively exhibit these metal and oxide (>50% Pu) inventories. Note: in 1994, the plutonium storage standard applied to oxides of > 50wt% plutonium, and therefore original tallies of the 94-1 inventory segregated oxides > 50wt% from less pure "residue and mixed oxide" material. The current DOE-STD-3013 standard now applies to oxides of > 30wt% plutonium.

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 (or, in the case of LANL, an electrolytic decontamination technology) 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. The scrub alloy from Rocky Flats underwent a separation process to remove constituents from the alloy which would otherwise make it unacceptable to the Materials Disposition program. In accordance with the first ROD for the *Residues and Scrub Alloy* EIS (issued November 25, 1998), all RFETS scrub alloy has been shipped to SRS for processing in the canyon facilities and has now (as of September 2001) been converted to metal.

Table E.2a: Plutonium Metals

APPENDIX F
LISTING OF COMPLETED ACTIONS

This attachment lists major accomplishments completed to date. The recent accomplishments are also shown in Chapter 4.

Hanford PFP

Completed transfer of 22,700 liters of PUREX solutions to tank farms, 4/95
Ensured all bottles containing Pu solutions are properly vented, 5/95
Stabilized existing inventory of low organic residues in muffle furnaces, 6/95
Stabilized 220 liters of chloride solutions, 9/95
Began engineering studies for a new repackaging line, 9/95
Stabilized 46 cans of selected RFETS ash in muffle furnaces, 1/96
Completed solution technology development, 4/96
Issued clean-out and stabilization EIS ROD, 6/96
Initiated thermal stabilization of Pu oxides and MOX, 1/99.
Documented approach for ash disposition, 1/99.
Completed a characterization of plutonium solutions, 2/99.
Decision on shipping and/or processing approach for select 94-1 materials at alternative sites, 2/99.
Decision on process selection for solutions that could not be processed untreated through the production vertical denitration calciner, 2/99.
Documented analysis and decision for processing of the inventory of unalloyed plutonium metal to meet DOE-STD-3013, 2/99.
Initiate operation of the prototype vertical denitration calciner, 9/99.
Documented decision for polycubes stabilization path forward, 2/00.
Magnesium hydroxide precipitation process started, 9/00
Initiated stabilization of plutonium metals, 9/00
Installed Bagless Transfer System, and began welding inner 3013 cans, 9/00
Completed repackaging of Rocky Flats Ash for disposition to WIPP, 3/01
Magnesium hydroxide precipitation process started in 9/00 and oxalate precipitation in 8/01
Completed metals stabilization and packaging, 9/01 (awaiting resolution of weld porosity issue to formally close out)
Thermal stabilization of plutonium oxides was reinitiated in January 1999, with over 750 items thermally stabilized as of 12/01
Completed Hanford Ash repackaging, 2/02
Completed direct discard of 1,000 liters of low concentration plutonium solutions, 3/02
High risk ash stabilized
All bottles of plutonium solution checked to ensure proper venting
Initiated polycube stabilization, 4/02

Hanford SNF

Performed K-basin sludge removal demonstration along with cofferdam installation, 12/94

Completed K-West Basin cofferdam installation, 2/95
Developed K-Basins potential funding options and acquisition strategy, 3/95
Issued K-Basin EIS NOI, 3/95
Completed K-East Basin cofferdam installation, 4/95
Began fuel characterization in K-Basin hot cells, 4/95
Issued K-Basin Integrated Path Forward Schedule providing details of major system acquisitions and materials movements, 4/95
Issued Management of SNF from K-Basins EIS ROD, 3/96
Initiated SNF movement from K-West Basin to Cold Vacuum Drying Facility, 12/00
Begin fuel removal from K-West Basin, 12/00
Progress at K-Basins

Savannah River

Isolated Am/Cm solution storage tank from cooling water systems, 2/95
Issued the ROD for the F-Canyon Plutonium Solutions EIS, 2/95
Restarted F-Canyon Second Pu Cycle Solvent Extraction (Operational Readiness Reviews), 2/95
Re-examined the L-Basin corrosion coupons, 2/95
Increased surveillance of the Am/Cm solution storage tank, 3/95
Repackaged all 14 containers of Pu-238 solids, 3/95
Completed L-Basin sludge consolidation, 3/95
Issued the Interim Management of Nuclear Materials (IMNM) Final EIS, 10/95
Restarted FB-Line (Operational Readiness Reviews), 11/95
Issued a Conceptual Design Report for the Am/Cm Vitrification Project, 11/95
Repackaged all plutonium metal in contact with plastic, 11/95
Completed re-orientation of L-Basin fuel, 11/95
Issued the first ROD for the IMNM Final EIS, 12/95
Restarted full F-Canyon operations (Operational Readiness Reviews), 2/96
Stabilized 303,000 liters of Pu solutions, 4/96
Completed SNF storage basin upgrades, 5/96
Stabilized all 46 containers of Pu-238 residues (concurrent with 94-1 scope), 6/96
Demonstrated direct casting for stabilization of miscellaneous Pu metal, 6/96
Completed RBOF fuel consolidation, 8/96
Restarted H-Canyon Frames Waste Recovery and HB-Line Phase III Pu-242 Operations (Readiness Reviews), 8/96
Stabilized all 3,500 gallons of Pu-242 solution, 12/96
Stabilized all 15,884 Mark-31 targets, 3/97
Installed digital radiography capability, 3/97
Stabilized all 83 containers of failed TRR and EBR-II SNF (concurrent with 94-1 scope), 6/97
Restarted H-Canyon dissolving of Mark-22 SNF (Operational Readiness Reviews), 7/97
Completed re-orientation of K-Basin fuel, 7/97
Started bagless transfer repackaging of Pu metal (Readiness Assessments), 8/97
Shipped all remaining high-assay Pu-238 offsite for program use (concurrent with 94-1 scope), 9/97
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 legacy Sand, Slag and Crucible residues, 7/98
Began HEU Solution Wash and Concentration in H-Canyon (Line Management Reviews), 8/98
Restarted F-Canyon 6.1D dissolver operations (Line Management Reviews), 8/98
Stabilized remaining 62 containers of TRR SNF (concurrent with 94-1 scope), 10/98
Implemented H-Canyon First Cycle Additional Criticality Controls (Readiness Assessment), 11/98
Completed dissolution of all 202 containers of legacy Pu-239 sweeping residues, 3/99
Began residue characterization in FB-Line (Line Management Reviews), 4/99
Dissolved 57 containers of RFETS SS&C residues transferred to the SRS, 4/99
Transferred SNM into the modified Building 235-F vault, 6/99
Completed bagless repackaging of all available plutonium metal, 7/99
Started HB-Line Low-Assay Plutonium dissolution (Readiness Assessment), 8/99
Started F-Canyon DU/Pu dissolution (Readiness Assessment), 8/99
Completed dissolution of 1,249 DU/Pu sintered oxide fuel rods, 10/99
Started Low-Assay Plutonium transfers from HB-Line to H-Canyon Tank 8.2 (Readiness Assessment), 1/00
Declared K-Area Material Storage operationally ready (Operational Readiness Reviews), 1/00
Completed dissolution of all 39 containers of Low-Assay Plutonium (concurrent with 94-1 scope), 1/00
Resumed BTS operations, 6/00
Completed Phase 3 H-Canyon Restart, 6/00
Began Building 235-F project conceptual design, 7/00
Resumed HB-Line dissolution of residues, 9/00
Began preliminary design of HEU Blend-down project, 11/00
Completed conceptual design for 235-F stabilization project, 1/01
Began detail design for 235-F stabilization project, 2/01
Began dissolution of RFETS scrub alloy, 3/01
Completed DOE/TVA interagency agreement for off-specification fuel program, 4/01
Completed transfer of HEU solution to double-walled tank, 7/01
Completed dissolution of RFETS scrub alloy, 9/01
Began converting pre-existing H-Canyon Pu-239 solution to oxide, 1/02
Completed dissolution of approximately 1,127 Mark-22 spent fuel assemblies, 3/02

Rocky Flats

Completed NEPA analysis (an Environmental Assessment) for solution stabilization, 4/95
Conducted sampling and inspection to determine relative risk and for repackaging Pu metals and oxides in close proximity to plastic and other synthetic materials, 9/95
Vented 2,045 residue drums with a potential for hydrogen gas generation, 9/95
Repackaged a total of 256 items in B707 where Pu is in direct contact with plastic, 11/95
Vented 700 unvented residue drums, 12/95
Vented all inorganic residues, 12/95
Vented all wet/miscellaneous residues, 12/95
Completed draining four (4) B771 hydroxide tanks, 8/96
Began bottling and shipping 2,700 liters of HEU solutions offsite for stabilization, 8/96

Started draining B771 hydroxide tanks and begin processing, 11/96
Removed all HEU uranyl nitrate solutions (2,700 liters) from B886 and completed all shipments offsite, 11/96
Started draining B371 tanks and begin processing, 12/96
Repackaged 1,602 Pu metal items not in direct contact, but in proximity to, plastic, 12/96
Thermally stabilized the existing backlog of all known RFETS reactive Pu oxide (63 kgs), 1/97
Completed draining six (6) B371 Cat B tanks, 2/97
Completed B771 hydroxide precipitation process, 3/97
Completed draining one (1) B371 criticality tank, 5/97
Repackaged all Pu metal in direct contact with plastic, 5/97
Completed processing liquids from seven (7) B371 tanks, 6/97
Started draining four (4) B771 high-level tanks and begin processing, 9/97
Completed draining four (4) B771 high-level tanks, 12/97
Started tap and drain of B771 room/systems, 1/98
Began stabilization by pyrochemical oxidation 6,000 kg of higher-risk salts, 1/98
Completed draining of remaining B371 criticality line tanks, 2/98
Started tap and drain of B371 room/systems, 6/98
Completed processing liquids from the B771 high-level tanks and B371 bottles, 7/98
Completed characterization of specified salt, combustibles, and IDC 368 to a 95/5 confidence level, 2/99
Completed stabilizing ion exchange resins, 3/99
Completed stabilizing ash residue IDC 333, 4/99
Completed draining and processing all B371 liquids, 6/99
Completed stabilizing high risk salts, 7/99
Drained 8 additional actinide systems in B771, 6/00
Completed repackaging of all salts, 11/00
Began packaging metal or oxide into 3013 containers, 6/01
Completed removal of all liquids in B771 (including all non-actinide systems), 10/01
Completed processing of all B771 liquids, 12/01

Oak Ridge

Completed MSRE interim corrective measures; drain water from the ACB cell, partition the off-gas system, eliminate the water sources, 11/95
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

Los Alamos

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
Performed a 100% inspection of vault inventory, 4/95
Recovered 100 neutron sources, 4/95
Processed 100 kgs of sand, slag and crucible materials, 4/95

Processed 70 kgs of hydroxide solids, 4/95
Began repackaging of Pu metal and oxide at the TA-55 Pu facility, 5/95
Processed 90% of analytical solutions, 8/95
Stabilized 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
Stabilized high-risk vault items to meet the long-term storage standards, 7/98
Stabilized 915 items, 9/99
Stabilized 410 items, 9/00
Stabilized 259 items, 9/01

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
Began Plutonium Packaging System (PuPS) operations, 02/01
Oxide Washer Operational, 11/01
Whole batch calcining and loss on ignition operational, 01/02

Idaho National Engineering and Environmental Laboratory

Began movement of CPP-603 South Basin SNF, 5/95
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
Constructed and started CPP-603 dry storage overpacking from CPP-603, 7/97
Completed removal of all spent nuclear fuel from the CPP-603 South Basin, 4/00

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

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]."

In FY1995, the Department of Energy initiated the 94-1 R&D Program under EM-60 (now EM-20) to work with the sites to identify high-priority technology needs, develop a process for plutonium stabilization, establish surveillance and monitoring technology, identify and characterize materials, and address issues in the technical bases of storage standards. A core team of researchers was assembled to assist the sites in the implementation of DNFSB Recommendation 94-1. EM-60 also chartered a Research Committee in March 1995 to systematically catalogue site needs. This Committee developed and issued the initial *94-1 Research and Development Plan* in November 1995. The 94-1 R&D Program has continued to the present providing technical support to site operations to stabilize, package, and store plutonium.

Accomplishments

Over the past several years, the EM-20 94-1 R&D Program has supported the updates to DOE-STD-3013, continued to develop the shelf-life programs to characterize and monitor representative site materials, developed a program for 3013 can surveillance, and provided high-priority technical support to sites.

The 94-1 R&D Program developed the technical basis for the original DOE-STD-3013-94 standard and developed the technical basis for each of the later revisions in 1996, 1999, and 2000. The technical data developed in the program allowed the concentration of plutonium accepted in the standard to be dropped from 50% to 30%. Additionally, the 94-1 R&D Program developed the technical basis to raise the storage temperature of containers holding metal to be raised from 100C to 250C by showing that the 3013 container would not fail during plutonium metal structure changes. This research saved the Department significant time and money by eliminating the need to build, design and operate a temperature controlled storage facility.

The Department had planned to use the Loss-on-Ignition moisture measurement method to validate that stabilized materials met the moisture requirement outlined in DOE-STD-3013. Testing performed by the 94-1 R&D Program on material from Rocky Flats, Hanford and LANL demonstrated that use of the LOI measurement method would cause significant quantities of materials to fail due to weight loss resulting from impurities rather than residual moisture. Had these studies not occurred early in the program, stabilization and processing at Rocky Flats would have been delayed many months.

Characterization of the plutonium and associated impurities was limited in the complex when the 94-1 R&D Program began. Consequently, the 94-1 R&D Program had to acquire and characterize items from Rocky Flats, Hanford and LANL. The 94-1 R&D Program has characterized most of the materials that will be packaged in 3013 containers, developed a database of properties that can be readily referenced by site representatives, and evaluated the stabilization process that will be used at sites. As part of this characterization and stabilization evaluation effort, a working group was formed to evaluate and direct the project based on site needs and issues. The MIS working group has been and is a very successful and closely coordinated team focused on coordinating 94-1 R&D Program efforts on site issues on stabilization, packaging, shipping and storage of plutonium metals and oxides.

Since characterization of the contents of materials is often limited to process knowledge, the 94-1 R&D Program developed an analytical method (prompt gamma analysis) that will interrogate the contents in the sealed container. This technique allows the sites to qualitatively identify many of the elements in the container without having to perform costly and time consuming chemical analysis.

The 94-1 R&D Program evaluated the materials and containers and determined most likely mechanisms to cause the storage containers to fail are corrosion and pressurization. Based on this evaluation, studies were designed and are currently being performed to evaluate the true potential for these mechanisms to actually fail the containers, to determine methods for early detection during storage, and provide accelerated data to identify insipient failures before they appear in the storage environment. To date these studies have shown only limited gas generation and corrosion thus demonstrating that the material at the sites can be safely stored in 3013 containers.

There have been numerous other accomplishments such as a 3013 container opening device that has been deployed at SRS and LANL, development of acoustic resonance spectroscopy for measuring gases in a sealed container, evaluation of numerous residue stabilization processes, development of moisture measuring methods, development of a method and equipment to remove carbon from the excess material, evaluation of deflagration and explosive potentials, thermal performance evaluation of storage containers, measurement of moisture adsorption rates after stabilization in varying glovebox humidity environments, to name a few. The 94-1 R&D Program has been very effective in assisting closure sites by addressing immediate issues that are identified by the sites, developing analytical, process, and surveillance methods and instruments and by looking ahead to solve potential problems before they become road blocks to site closure.

Current Activities

The 94-1 R&D Program objectives continue to be directly tied to EM site closure initiatives and to the requirements outlined in DOE-STD-3013. Building upon the successes of previous years, the Program continues to provide significant support to the closure and storage sites to assure that the 3013 materials will exist in a safe and secure status until final disposition.

The Program assists the closure sites by providing necessary technology and technical support to meet closure schedules by providing the technical basis for risk-based prioritization, stabilization process development, and packaging requirements for safe shipment. Specifically, the current work scope reflects a focus on moisture measurement issue resolution, the qualification of specific stabilization processes, the progression of the DOE-STD-3013 technical basis, and the validation of a gas generation model for pure oxides. Examination of processing parameters for process qualification will be conducted by both laboratory studies and engineering analyses of unexpected failures.

The Program also assists in the development of storage standards. This includes performing accelerated shelf-life studies for detection of incipient failure mechanisms, and developing a complex-wide surveillance philosophy, program and implementation plan that provides a cost effective integrated program with the consolidation of information into one central location.

An essential part of this Program is the Core Technology, which seeks to improve the technical understanding of the stabilization process and material behavior during storage to provide technically defensible information and support safe long-term storage of stabilized materials in approved packages. It also assures that technical capabilities will be available in the future to deal with unforeseen problems. Currently the work is focused on plutonium-bearing materials that are to be stabilized, packaged and stored per the requirements outlined in the DOE-STD-3013. As the issues associated with these materials are resolved the Program will evaluate the need to expand to include other actinide materials. Additionally, the development of a plan for encapsulating the 3013 packages in glass is underway to identify a disposition path for the 3013 materials that may not meet MOX criteria.

Future Activities

The 94-1 R&D Program will continue to resolve technical issues necessary to ensure with high confidence that all 3013 materials can be safely stabilized, packaged and stored for up to 50 years pending ultimate disposition. Specific future efforts and related milestones will be directly dependent on the packaging schedules and closure dates of the 3013 sites and ultimately dependent on the final disposition of the last item. As required, the 94-1 R&D Program will continue to support the sites performing stabilization and packaging of materials. To assure safe storage of materials through final disposition, the 94-1 R&D Program will maintain represented materials, perform shelf-life studies and surveillance activities, and maintain the Core Technology Program.

Surveillance of 3013 containers through the integrated surveillance program will include destructive and nondestructive evaluation of the 3013 containers, chemistry analysis of the stored materials, maintenance of a database, and analysis of baseline and surveillance data as it is collected. The shelf life experiments will help identify potential failure mechanisms and assist in the identification of critical material types in which to focus surveillance activities. The Core Technology program will ensures that a sound scientific basis and expertise exists for stabilization, packaging and storage of the 3013 materials for up to 50 years. Additionally, the program will evaluate the necessity to develop standards and perform research on other actinide materials in support of the materials cleanup and closure of sites.

Summary

A schematic of the profile of anticipated support in the out years is shown in Figure G.1. It is anticipated that following the RFETS closure, the 94-1 R&D activities will support the closure of the Hanford site and support reduction of excess plutonium inventory at SRS, LANL, and LLNL. In the near term as described above, the 94-1 Program continues to support the stabilization and packaging sites through a variety of activities including process qualification and material identification. As RFETS and then Hanford near closure and their 3013 material is in storage, the 94-1 Program will be focused primarily on supporting long term surveillance and storage issues.

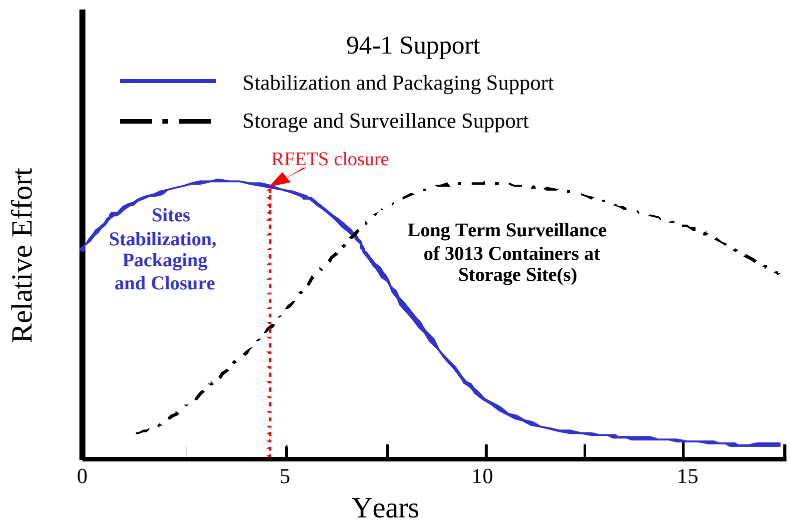

Figure G-1. 94-1 Program support and focus areas during site stabilization, packaging and closure to long term surveillance and storage of the 3013 containers. The anticipated closure of RFETS is indicated.

APPENDIX H
HISTORY OF DOE-DNFSB INTERACTIONS

This Appendix briefly chronicles the history of DOE and DNFSB interactions to address the safe remediation of facilities and materials in the former nuclear weapons complex. This account is by no means comprehensive, but is intended to provide sufficient context for the issuance of this plan as the latest Departmental representation of actions in the recent past, present, and near term.

H.1 Underlying Causes for Attention to Safety Issues in the Former Nuclear Weapons Complex

Throughout the Cold War, the DOE 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. Subsequent world events have been such that the shutdown facilities have not resumed production. Consequently, the Department shifted its emphasis from nuclear material production to EM activities that include measures to mitigate 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 and early 1990s, many materials were left in conditions unsuitable for long-term storage.

H.2 1990s History: Department Activities and DNFSB Recommendation 94-1

Initial DOE Complex-Wide Assessments of Inventory and Safety-Related Issues

In the early- to mid-1990s, the Department initiated activities to investigate the conditions of its nuclear materials. 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 were heretofore limited to those undertaken by individual field organizations and constrained by each site's resources. Consequently, the stabilization of nuclear materials 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).

DNFSB Recommendation 94-1

On May 26, 1994, the DNFSB 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 (ongoing) plutonium and (completed) spent fuel assessments. In this recommendation, the Board noted 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.

DOE Response, 1994-2000

The Department accepted the DNFSB Recommendation 94-1 on August 31, 1994, and in response submitted its (first) IP on February 28, 1995. This IP ("Remediation of Nuclear Materials in the Defense Nuclear Facilities Complex") represented an integrated Department-wide program to provide timely mitigation of those conditions 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 SRS. These materials require timely stabilization and repackaging to prevent further deterioration of conditions and a corresponding increase in the already unacceptable safety risks.

- The production and processing of plutonium and other nuclear materials at Hanford, the Idaho National Engineering and Environmental Laboratory, and SRS 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 metal weapons 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 SRS. The risks associated with the highest risk solid deposits of uranium isotopes in an uranium enrichment facility at Oak Ridge have been mitigated. SRS 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 nuclear materials at Savannah River left a particularly hazardous inventory of special isotopes in both solution and solid forms that present significant safety risks.

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.

A number of modifications to the 94-1 IP became necessary in the years following its original preparation. These modifications were due to approval of major Departmental initiatives such as:

- *Accelerating Cleanup: Paths to Closure*, which described 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 outlined specific actions the Department would take to accelerate the cleanup and closure of Rocky Flats

- The Record of Decision (ROD) 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 ROD for the Programmatic Environmental Impact Statement for *Stockpile Stewardship and Management* within the Office of Defense Programs which assigned new missions to some DP facilities

Modifications were also necessitated by technical improvements, previously unforeseen problems, and schedule changes that were 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 IP to capture all known and planned changes from the original Plan. Revision 1 of the IP was approved by the Secretary of Energy in December 1998. The Board only conditionally accepted Revision 1 of the IP, citing uncertainties about the Department's path forward for plutonium stabilization and storage in light of the hold that had been placed on construction of the Actinide Packaging and Storage Facility at SRS.

In addition, as Revision 1 was being prepared, an intensive rebaselining effort was underway for stabilization activities at the Hanford PFP. The results of that rebaselining were reflected in Revision 2, approved on February 1, 2000, which also included updated plans for Rocky Flats, Oak Ridge, LLNL, and Idaho.

DNFSB Recommendation 2000-1

On January 14, 2000, the Board issued its Recommendation 2000-1, which dealt with the same technical issues as 94-1, citing progress to date and listing outstanding issues requiring remediation. In Recommendation 2000-1, the Board expressed its concern that remediation activities were not being accomplished on the schedules originally agreed to, nor was there the same sense of urgency that had originally been their intent with 94-1. The Department acknowledges and continues to share the Board's concerns and has developed this revision of the 2000-1 IP continue to address these urgent problems.

DOE Response, 2000 to Present

Revision 3 of the IP, approved on June 8, 2000, responded to both Recommendations 94-1 and 2000-1. This plan updated the status of actions at all affected DOE facilities. This revision also described a path forward for SRS that did not include the previously proposed Actinide Packaging and Storage Facility.

In mid-2000, the Office of Defense Programs outlined a process which they would follow to prepare an integrated plan with milestones for stabilization or discard of remaining 94-1 materials at LANL. Revision 1 to the 2000-1 IP was prepared mainly to incorporate these LANL plans. In a March 23, 2001 letter, the Board accepted this revision except for certain elements of the LANL and SRS plans.

This current revision significantly updates these LANL and SRS plans. Also shown are other updated plans for stabilizing spent nuclear fuel at Hanford and plutonium located at the Hanford PFP, RFETS, LLNL, and ORNL.

Given this history to date of interactions between the Department and the Board, and the emergence of issues over time as inventories are stabilized for long-term storage, this document should be viewed as the latest depiction of plans that could change, particularly if the assumptions of Chapter 3 do not hold or if refinements to current knowledge (e.g., improved characterization of items in inventory) call for changes.

APPENDIX I
DNFSB RECOMMENDATION 94-1

For convenient reference, this Appendix contains DNFSB Recommendation 94-1.

[DNFSB LETTERHEAD]

May 26, 1994

The Honorable Hazel R. O'Leary
Secretary of Energy
Washington, DC 20585

Dear Secretary O'Leary:

On May 26, 1994 the Defense Nuclear Safety Board, in accordance with 42 U.S.C. § 2286a(5), unanimously approved Recommendation 94-1 which is enclosed for your consideration. Recommendation 94-1 deals with Improved Schedule for Remediation in the Defense Nuclear Facilities Complex.

42 U.S.C.§ 2286d(a) requires the Board, after receipt by you, to promptly make this recommendation available to the public in the Department of Energy's regional public reading rooms. The Board believes the recommendation contains no information which is classified or otherwise restricted. To the extent this recommendation does not include information restricted by DOE under the Atomic Energy Act of 1954, 42 U.S.C. §§ 2161-68, as amended, please arrange to have this recommendation promptly placed on file in your regional public reading rooms.

The Board will publish this recommendation in the Federal Register.

Sincerely,

John T. Conway
Chairman

Enclosure

Copy to: Mark B. Whitaker, EH-6

RECOMMENDATION 94-1 TO THE SECRETARY OF ENERGY
pursuant to 42 U.S.C. § 2286a(5) Atomic Energy Act of 1954, as amended.

Dated: **May 26, 1994**

The halt in production of nuclear weapons and 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. The Board has concluded from observations and discussions with others that imminent hazards could arise within two to three years unless certain problems are corrected.

We are especially concerned about specific liquids and solids containing fissile materials and other radioactive substances in spent fuel storage pools, reactor basins, reprocessing canyons, processing lines, and various buildings once used for processing and weapons manufacture.

It is not clear at this juncture how fissile materials produced for defense purposes will eventually be dealt with long term. What is clear is that the extant fissile materials and related materials require treatment on an accelerated basis to convert them to forms more suitable for safe interim storage.

The Board is especially concerned about the following situations:

- Several large tanks in the F-Canyon at the Savannah River Site contain tens of thousands of gallons of solutions of plutonium and trans-plutonium isotopes. The trans-plutonium solutions remain from californium-252 production; they include highly radioactive isotopes of americium and curium. These tanks, their appendages, and vital support systems are old, subject to deterioration, prone to leakage, and are not seismically qualified. If an earthquake or other accident were to breach the tanks, F-Canyon would become so contaminated that cleanup would be practically impossible. Containment of the radioactive material under such circumstances would be highly uncertain.

- The K-East Basin at the Hanford Site contains hundreds of tons of deteriorating irradiated nuclear fuel from the N-Reactor. This fuel has been heavily corroded during its long period of storage under water, and the bottom of the basin is now covered by a thick deposit of sludge containing actinide compounds and fission products. The basin is near the Columbia River. It has leaked on several occasions, is likely to leak again, and has design and construction defects that make it seismically unsafe.

- The 603 Basin at the Idaho National Engineering Laboratory (INEL) contains deteriorating irradiated reactor fuel from a number of sources. This basin also contains sludge from corrosion of the reactor fuel. The seismic competence of the 603 Basin is not established.

- Processing canyons and reactor basins at the Savannah River Site contain large amounts of deteriorating irradiated reactor fuel stored under conditions similar to those at the 603 Basin at INEL.

- There are thousands of containers of plutonium-bearing liquids and solids at the Rocky Flats Plant, the Hanford Site, the Savannah River Site, and the Los Alamos National Laboratory. These materials were in the nuclear-weapons manufacturing pipeline when manufacturing ended. Large quantities of plutonium solutions are stored in deteriorating tanks, piping, and plastic bottles. Thousands of containers at the Rocky Flats Plant hold miscellaneous plutonium-bearing materials classed as "residuals", some of which are chemically unstable. Many of the containers of plutonium metal also contain plastic and, in some at the Rocky Flats Plant, the plastic is believed to be in intimate contact with the plutonium. It is well known that plutonium in contact with plastic can cause formation of hydrogen gas and pyrophoric plutonium compounds leading to a high probability of plutonium fires.

We note that removal of fissile materials from the 603 Basin at INEL has begun. We are also following the plans for remedying several of the other situations listed. In general, these plans are at an early stage. In addition, we are aware of steps DOE has taken to assess spent fuel inventories and vulnerabilities. We also note that a number of environmental assessments are being conducted in relation to the situations we have listed above. Finally, we note that a draft DOE Standard has been prepared for methods to be used in safe storage of plutonium metal and plutonium oxide.

These actions notwithstanding, the Board is concerned about the slow pace of remediation. The Board believes that additional delays in stabilizing these materials will be accompanied by further deterioration of safety and unnecessary increased risks to workers and the public.

Therefore the Board recommends:

(1) That an integrated program plan be formulated on a high priority basis, to convert within two to three years the materials addressed in the specific recommendations below, to forms or conditions suitable for safe interim storage. This plan should recognize that remediation will require a systems engineering approach, involving integration of facilities and capabilities at a number of sites, and will require attention to limiting worker exposure and minimizing generation of additional waste and emission of effluents to the environment. The plan should include a provision that, within a reasonable period of time (such as eight years), all storage of plutonium metal and oxide should be in conformance with the draft DOE Standard on storage of plutonium now being made final.

(2) That a research program be established to fill any gaps in the information base needed for choosing among the alternate processes to be used in safe conversion of various types of fissile materials to optimal forms for safe interim storage and the longer term disposition. Development of this research should be addressed in the program plan called for by (1) above.

(3) That preparations be expedited to process the dissolved plutonium and transplutonium isotopes in tanks in the F-Canyon at the Savannah River Site into forms safer for interim storage. The Board considers this problem to be especially urgent.

(4) That preparations be expedited to repackage the plutonium metal that is in contact with, or

in proximity to, plastic or to eliminate the associated existing hazard in any other way that is feasible and reliable. Storage of plutonium materials generated through this remediation process should be such that containers need not be opened again for additional treatment for a reasonably long time.

(5) That preparations be expedited to process the containers of possibly unstable residues at the Rocky Flats Plant and to convert constituent plutonium to a form suitable for safe interim storage.

(6) That preparations be expedited to process the deteriorating irradiated reactor fuel stored in basins at the Savannah River Site into a form suitable for safe interim storage until an option for ultimate disposition is selected.

(7) That the program be accelerated to place the deteriorating reactor fuel in the K-East Basin at the Hanford Site in a stable configuration for interim storage until an option for ultimate disposition is chosen. This program needs to be directed toward storage methods that will minimize further deterioration.

(8) That those facilities that may be needed for future handling and treatment of the materials in question be maintained in a usable state. Candidate facilities include, among others, the F- and H-Canyons and the FB- and HB-Lines at the Savannah River Site, some plutonium-handling glove box lines among those at the Rocky Flats Plant, the Los Alamos National Laboratory, and the Hanford Site, and certain facilities necessary to support a uranium handling capability at the Y-12 Plant at the Oak Ridge Site.

(9) Expedited preparations to accomplish actions in items (3) through (7) above should take into account the need to meet the requirements for operational readiness in accordance with DOE Order 5480.31.

John T. Conway, Chairman

APPENDIX J
DNFSB RECOMMENDATION 2000-1

For convenient reference, this appendix contains DNFSB Recommendation 2000-1.

[DNFSB LETTERHEAD]

January 14, 2000

The Honorable Bill Richardson
Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Richardson:

On May 26, 1994, the Defense Nuclear Facilities Safety Board (Board) submitted to the Secretary of Energy Recommendation 94-1, dealing with the need to stabilize and safely store large amounts of fissionable and other nuclear material that for safety reasons should not be permitted to remain unremediated. The Board was especially concerned about specific liquids and solids in spent fuel storage pools, reactor basins, reprocessing canyons, processing lines and various defense facilities remaining in the manufacturing pipeline when pit production was terminated in 1988. On August 31, 1994, Secretary O'Leary agreed with and accepted the recommendation. On February 28, 1995, Secretary O'Leary forwarded to the Board the Department of Energy's (DOE) plan for implementation of the Boards recommendation on this issue. Subsequently, on December 28, 1998, you forwarded to the Board a revision to Secretary O'Leary's original Implementation Plan for Recommendation 94-1.

During the past year, the Board and its staff have been closely following and noting further slippage in the time table for meeting the dates set forth in the Implementation Plan. While a great deal has been accomplished in meeting the safety objective set forth in Recommendation 94-1 particularly with regard to those materials that constituted the most imminent hazards, the Board is concerned that severe problems continue to exist and delay the implementation of Recommendation 94-1. After careful consideration, the Board has concluded that the progress being made in certain of the stabilization activities addressed by Recommendation 94-1 does not reflect the urgency that the circumstances merit and that was central to the Board's recommendation.

The Board will continue to follow and urge DOE to implement Recommendation 94-1. In addition, the Board, on January 14, 2000, unanimously approved Recommendation 2000-1 which is enclosed for your consideration.

42 U.S.C. § 2286d(a) requires that after your receipt of this recommendation, the Board promptly

make it available to the public in DOE's regional public reading rooms. The Board believes the recommendation contains no information that is classified or otherwise restricted.

To the extent this recommendation does not include information restricted by DOE under the Atomic Energy Act of 1954, 42 U.S.C. §§ 2161-68, as amended, please arrange to have it promptly placed on file in your regional public reading rooms.

The Board will also publish this recommendation in the *Federal Register*.

Sincerely,

John T. Conway
Chairman

Enclosure

c: Mr. Mark B. Whitaker, Jr.

DEFENSE NUCLEAR FACILITIES SAFETY BOARD
RECOMMENDATION 2000-1 TO THE SECRETARY OF ENERGY
pursuant to 42 U.S.C. § 2286a(a)(5)
Atomic Energy Act of 1954, as amended

Dated: January 14, 2000

Background

It is now almost six years since the Defense Nuclear Facilities Safety Board (Board) transmitted to the Secretary of Energy its Recommendation 94-1 entitled, "Improved Schedule for Remediation in Defense Nuclear Facilities Complex." That Recommendation pointed to the existence of large quantities of unstable fissionable material and other radioactive material that had been left in the production pipeline following termination of nuclear weapons production. These materials required prompt conversion to more stable forms, to prevent deterioration leading to inevitable spread of radioactive contamination. Further, some of the material was in such a state that serious safety problems could be expected in a very short period of time if remediation did not take place.

The Recommendation identified safety problems posed by plutonium both as metal and in chemical compounds, and plutonium-bearing materials such as residues and spent nuclear fuel. Most of this material was and still is at three sites: Savannah River, Hanford, and Rocky Flats Environmental Technology Site (RFETS). A substantial amount of spent nuclear fuel also existed at the Idaho National Engineering and Environmental Laboratory. In the Implementation Plan responding to the Recommendation, the Department of Energy (DOE) justifiably saw fit to add to the sources of concern the enriched uranium solution stored at the Savannah River Site, accumulated from processing of spent nuclear fuel, and the highly radioactive uranium-233 in the decommissioned Molten Salt Reactor Experiment (MSRE) at the Oak Ridge National Laboratory. The highly enriched uranium solution, amounting to many thousands of gallons of liquid, is stored outside the H-Canyon in large tanks where over a period of time precipitation resulting from freezing, chemical changes, or evaporation of liquid could produce sediments posing a threat of accidental criticality. The MSRE has been shut down for many decades, and deterioration, the onset of which had already been detected, could in time release its radioactive material into the environment.

Materials Stabilized Since the Recommendation

In the years since the Recommendation, progress has been made at defense nuclear facilities in remediating the most hazardous material. Most sites have repackaged plutonium metal and oxides that had been left in containers in contact with plastic that could become a source of hydrogen gas. Deteriorating spent nuclear fuel elements stored in the 603 Basin at the Idaho National Engineering and Environmental Laboratory have been moved to the 666 Basin where control of water purity is much better. Substantial amounts of spent nuclear fuel elements and nuclear targets stored in basins at the Savannah River Site have been chemically processed and plutonium and other radioactive material so extracted have been stored. Most of the plutonium in solution at the Savannah River Site has been converted to metal and along with other plutonium metal at the Site has been packaged in seal-welded containers with inert atmospheres by means of the bagless transfer system. Almost all of the plutonium-bearing solutions in facilities at the RFETS have been chemically treated to remove the plutonium, which has then been stored as more stable oxide. Numerous drums containing radioactive residues, mostly at the RFETS, have been vented to prevent buildup of pressure by gas liberated through chemical reactions and by effects of radioactive decay. Though non-technical problems continue to plague actions to store nuclear waste in the Waste Isolation Pilot Plant (WIPP) facility in New Mexico, some storage at that site has taken place, and presumably momentum will build toward highly important shipment of more material to that disposal site. In these ways, most of the very immediate concerns prompting the Recommendation have been eased.

Furthermore, after a long period when it seemed that little was being accomplished, progress has been made toward cleanup of the important K-East and K-West fuel storage basins at the Hanford Site. Remediation of many of the cleanup problems at the RFETS has taken on momentum after a long initial period when little was accomplished. Some of the most notable advances have been made by arrangements to ship plutonium-bearing material to the Savannah River Site and to WIPP.

Approximately 300,000 liters of plutonium solution in the F-Canyon at the Savannah River Site have now been converted to metal in the FB-Line. This material is stored in approximately 80 welded stainless steel cans that will serve as the inner containers to meet DOE-STD-3013.

Plutonium solutions resulting from stabilization of Mark-31 spent nuclear fuel have also been converted to metal, and along with the preexisting metal items in the FB-Line, are also stored in similar DOE-STD-3013 inner containers.

Problems Remaining

Severe problems continue to impede other remedial measures that had been promised in the original Implementation Plan issued by the Secretary of Energy in response to Recommendation 94-1, and in Revision 1 to that Plan as issued on December 28, 1998. For a variety of reasons, many of them stated below, most of the remaining milestones in the Implementation Plans will not be met. Among the remaining problems are the following:

- Approximately 34,000 liters of plutonium-bearing solution remain in the H-Canyon at the Savannah River Site. Originally this material was to have been stabilized by March 2000 in the HB-Line Phase 2 facility; however, preparing that facility for operation was not funded in FY 1999. The revised Implementation Plan deferred stabilization until June 2002. The contractor has provided an unofficial revised estimate of completion by December 2002, but that date is alleged to be at risk because the resources (mainly technical personnel) are not available to support development of procedures and Authorization Basis documents. There is at present no high confidence startup schedule.

- In the F-Area at the Savannah River Site are approximately 800 kilograms of plutonium oxide. This oxide was to have been fired at high temperature in accordance with DOE-STD-3013 and packaged in 3013-compliant containers by May 2002. So far there has been no appreciable action toward these objectives. The stated reason has been deferral of a decision to build the Actinide Packaging and Storage Facility (APSF), though as the Board noted in an earlier letter to the Assistant Secretary for Environmental Management, a decision not to build the facility appears already to have been made. This activity is at present not funded, nor is any funding planned for a facility which could be used in stabilizing and storing this material. Though Implementation Plans had originally set target dates for accomplishment of the actions, no dates based on revised plans have been established.

- In the F-Area at the Savannah River Site are also about 400 kilograms of plutonium in the form of miscellaneous residues. Several paths for processing the residues have been proposed, depending on their characteristics, but all the plutonium should end up as metal or oxide fired at high temperature according to DOE-STD-3013. Originally all were to occur by May 2002. Other than startup of the FB-Line for characterizing the material, there has been no appreciable action so far toward the final objectives. As for the oxides referred to above, stabilization and packaging of this material were to be accomplished in the APSF, and are now being delayed.

- One tank in the F-Canyon at Savannah River contains approximately 14,400 liters of a solution of americium and curium. These elements, which are highly radioactive, are raw materials for production of californium-252 (Cf^{252}) in the High Flux Isotope Reactor at Oak Ridge. There are continuing needs for Cf^{252}. Dispersal of the americium and curium material through loss of integrity of the tank and its appendages, such as might be caused by corrosion or seismic action, would create an almost insurmountable problem of spread of radioactive contamination. The original Implementation Plan foresaw conversion of the dissolved elements by November 1999 to a vitreous form suitable for storage until use. Difficulties with the melter planned for the operation caused deferral of the operation to September 2002 according to the revised Implementation Plan. At present the activity is alleged to be under-funded, though a Request for Proposal has been issued seeking a commercial contract for the action. The most optimistic estimate of a completion date is November 2004.

- About 6,000 liters of a solution of neptunium-237 (Np^{237})are in tanks in the H-Canyon at the Savannah River Site. This isotope is the raw material for production of plutonium-238 (Pu^{238}), which has such uses as a heat source for production of electricity for some NASA missions. Initial plans were to vitrify this material by September 2003. The revised Implementation Plan stated that instead it was to be converted to oxide through use of the HB-Line Phase 2 facility. The revised Implementation Plan deferred the estimated date of completion to December 2005. An additional six-month delay is now foreseen, though that view may still be optimistic since adequacy of funding so far in the future cannot be assured.

- About 230,000 liters of highly-enriched uranyl nitrate solution are held in tanks outside the H-Canyon at the Savannah River Site. The quantity of solution will continue to increase as a result of stabilization of spent Mark 16/22 fuel elements. This solution is a hazard because freezing, evaporation, or chemical change could lead to a uranium concentration and a threat of accidental criticality. The intent has been to add depleted uranium to this solution, reducing the enrichment to a range suitable for use in fuel elements for Tennessee Valley Authority's light water reactors. Though the Tennessee Valley Authority has concurred in principle with the arrangement, an agreement to proceed has been held up by allegedly insufficient out-year funding by DOE to execute its share of the agreement. Meanwhile, the estimated costs have been increasing. An original date of December 1997 had been set for conversion of the uranium to oxide. The revised Implementation Plan delayed that date by six years to December 2003. There is no credible date for removal of the hazard. Assigned storage space for the solution is now nearly full.

- About seven tonnes of heavy metal, principally highly-enriched uranium, is still in irradiated Mark 16/22 fuel elements at the Savannah River Site. A campaign to process Mark 16/22 fuel elements was to have been completed by December 2000, according to the original Implementation Plan. The revised Plan changed that date to December 2001. The processing is now only about 25% complete, because of an alleged shortage of personnel and some technical issues delaying restart of the H-Canyon second solvent extraction cycle. Mark 16/22 fuel element processing stopped in September 1999 and will not resume until startup of second cycle operations, which is now scheduled for April 2000. The stated completion date is now about May 2003, though processing may have to be halted again in the future because of inadequate additional space for storage of uranium solutions (see the previous item).

- The Plutonium Finishing Plant (PFP) at the Hanford Site contains more than 300 kilograms of plutonium in 4,300 liters of solution. This was to have been stabilized by January 1999 through use of a vertical denigration calciner. Technical problems and allegedly insufficient financial resources hampered completion of the vertical calciner and treatment of the solution by that date, and attempts to improve the schedule through use of a prototype calciner were also inadequate. The plan has recently been changed, and it is now intended that the plutonium will be precipitated and thermally stabilized by December 2001, by means of the magnesium hydroxide process. Although this process has already been used to stabilize thousands of liters of solution at the RFETS, DOE and its contractor at Hanford are still trying to prove it will work with the PFP solutions. The story of inability to treat plutonium solutions at PFP has been typical of a sequence of ineffective activities at that Plant, generally the result of poor management.

- Approximately 700 kilograms of plutonium exist at PFP in the form of metal or alloys. The facility has spent a significant amount of time pursuing various alternative strategies for processing and packaging this material and now plans to brush loose oxide from the metal and package it in welded double containers in accordance with DOE-STD-3013 by March 2001, a noteworthy improvement over the original Implementation Plan's date of May 2002. The oxide from brushing and some severely corroded metal would be thermally stabilized to oxide as called for by the standard and added to the material in the following item.

- About 1,500 kilograms of plutonium exist at PFP in the form of oxide. About one year ago the staff at PFP began stabilizing this material through use of two muffle furnaces. The throughput of two furnaces was not enough to deal with the quantity of material in existence, but it was initially claimed that available funds were inadequate for installation of additional furnaces. It is now planned that three additional furnaces are to be brought on line by February 2000, and four more double capacity furnaces in May 2002. The oxide will be packaged to meet DOE-STD-3013 after stabilization. The original Implementation Plan proposed completion of packaging by May 2002. The present plan would accomplish the job by about May 2004.

- Several dozen kilograms of plutonium exist at the PFP dispersed in approximately 1,600 polystyrene cubes, called polycubes. This material was used in the past in criticality studies. The polycubes have become friable through the effects of radiolysis and have become a contamination dispersal hazard. The method of treatment and stabilization of this material was under discussion for some time with various alternatives being considered. At present it is planned to oxidize the material in the muffle furnaces with the polystyrene converted to gas and the plutonium converted to stable oxide and then packaged as above. The original Implementation Plan proposed completion of treatment by some method by January 2001. Although the current goal is treatment by August 2002, this date may be delayed when the throughput of the muffle furnaces is determined in February 2000.

- Hundreds of kilograms of plutonium are in residues of various forms at PFP. These were to have been packaged and disposed of by different methods by May 2002 according to the original Implementation Plan. Cementation of sand, slag, and crucible materials began, but that process was shut down several years ago after only 240 kilograms had been treated. It is now planned that the activity will be completed by April 2004.

- The K- East and K-West fuel storage basins at the Hanford Site contain approximately 2,100 tonnes of spent uranium fuel from past operation of the N-Reactor. At one time this material was to have been chemically processed in the Purex plant, but it was left stranded when DOE decided about ten years ago to decommission Purex. The spent fuel at these basins has been corroding for some decades and since the Basins are very near the Columbia River and have been known to leak during the past, remediation of this situation has been high on the Board's priority list. Progress toward remediation had seemed adequate some time ago, but with the change of contractors at Hanford a few years ago progress appeared to stall. Resumption of progress has recently been noted, but years of schedule loss have occurred. This activity has consumed a large part of the financing that had been planned for other activities at the Hanford Site such as cleanup of PFP. The planned date of cleanout of the Basins had been December 1999 according to the original Implementation Plan. It is now anticipated that removal of fuel from the Basins will be completed by December 2003, and removal of sludge from oxidation will have been accomplished by August 2005. By that time cleanup of these Basins will have cost between one and two billion dollars.

- About one tonne of plutonium metal and oxide at the Los Alamos National Laboratory was recently declared to be excess to the needs of the defense program, and it awaits repackaging in accordance with DOE-STD-3013. According to the original Implementation Plan repackaging should take place by May 2002. At present there is no plan for repackaging any of the material.

- More than one tonne of plutonium exists in residues at the Los Alamos National Laboratory. The original Implementation Plan estimated that all would have been stabilized and repackaged by May 2002. All high risk items have been processed at this time. Although newly produced residues are being properly packaged, little work is being done at this time to take care of legacy residues. The estimated date for dealing with the legacy materials is now September 2005.

The above are not all of the materials referred to in Recommendation 94-1, but they are the major ones for which remediation schedules have fallen well behind those contemplated by the Recommendation and by the original Implementation Plan.

Fiscal Problem

The most common reason given for failure to meet schedules has been insufficient financial support. That being so, the Board does not understand why the Department of Energy has not obeyed the statutory requirement in the Atomic Energy Act as amended in 42 U.S.C. § 2286d(f)(2),

> (2) If the Secretary of Energy determines that the implementation of a Board recommendation (or part thereof) is impracticable because of budgetary considerations, or that the implementation would affect the Secretary's ability to meet the annual nuclear weapons stockpile requirements established pursuant to section 91 of this Act [42 U.S.C. § 2121], the Secretary shall submit to the President, to the Committees on Armed Services and on Appropriations of the Senate, and to the Speaker of the House of Representatives a report containing the recommendation and the Secretary's determination.

In any case, simultaneous implementation of all elements of Recommendation 94-1 to schedules previously committed seems to be impossible under present circumstances allegedly because of budgetary constraints. Given this fiscal reality, DOE is faced with the need to:

1. advise Congress and the President of the shortfall in funds to satisfy all the safety enhancements to meet Recommendation 94-1, and

2. prioritize and schedule tasks to be undertaken with available funds according to consideration of risks.

Recommendation

In the Board's view, material remaining in liquids generally poses the greatest hazard, because of higher possibility of dispersal and because of potential criticality. Among these liquids the highly enriched uranium solutions stored in tanks outside the H-Canyon at the Savannah River Site require the most attention because of criticality concerns. Following the solutions in importance are unstabilized plutonium oxides and plutonium metal remaining in containers with normal atmosphere, especially at locations in moist climates. Closely following in importance are various plutonium-bearing residues which are not as well isolated or packaged as they should be. Accordingly, the Board recommends the following technical actions in descending order of priority.

1. Stabilize the uranium solution in tanks outside the H-Canyon at the Savannah River Site, to remove criticality concerns. This should not await plans to convert the uranium to fuel for Tennessee Valley Authority's nuclear reactors.

2. Remediate the highly-radioactive solutions of americium and curium in the F-Canyon at the Savannah River Site. The currently-planned deferral of vitrification of this material is highly undesirable.

3. Remediate the solution of neptunium now stored in H-Canyon at the Savannah River Site.

4. Convert remaining plutonium solutions to stable oxides or metals, and subsequently package them into welded containers with inert atmosphere. The principal remaining solutions are in H-Canyon at the Savannah River Site, and the Plutonium Finishing Plant at the Hanford Site.

5. Treat the plutonium-bearing polycubes at PFP to remove and stabilize the plutonium.

6. Continue stabilization of spent nuclear fuel at Savannah River.

7. Stabilize and seal within welded containers with an inert atmosphere the plutonium oxides produced by various processes at defense nuclear facilities, and which are not yet in states conforming to the long-term storage envisaged by DOE-STD-3013. These oxides are found at the F Area of the Savannah River Site, the RFETS, the Plutonium Finishing Plant at the Hanford Site, the Lawrence Livermore National Laboratory, and the Los Alamos National Laboratory.

8. Enclose existing and newly-generated legacy plutonium metal in sealed containers with an inert atmosphere. Removal of loose oxide should of course take place just before sealing.

9. Remediate and/or safely store the various residues which are found at all three of the production sites, as well as the Lawrence Livermore National Laboratory and the Los Alamos National Laboratory.

It is assumed that the schedule for remediation of the spent fuel in the K-Basins at the Hanford Site will continue as currently planned.

The ordering of priorities should not be understood as implying a lack of importance attached to those lower in the sequence. It is simply a recognition that under the circumstances the greater hazards should be addressed first and with greatest firmness. All elements of the original Recommendation 94-1 retain their importance and none are to be considered unessential.

Also, the Board’s staff has been discussing with DOE staff an ordering of tasks subject to Recommendation 94-1 in accordance with ease of their performance. Those actions which can readily be conducted within present resources should certainly go forward, as long as items of high safety priority receive the proper attention.

The severity of the problems which are the subject of this Recommendation and Recommendation 94-1 and the urgency to remediate them argue forcefully for the Secretary to avail himself of the authority under the Atomic Energy Act to "implement any such Recommendation (or part of any such Recommendation) before, on, or after the date on which the Secretary transmits the implementation plan to the Board under this subsection." *See*, 42 U.S.C. § 2286d(e). The Board suggests that the Secretary avail himself of this provision.

In addition, because stabilization of materials remaining from the Weapons Production Program continues to be of such importance, the Board recommends that:

10. An estimate be made of the total funding shortfall for timely completion of all 94-1 commitments according to the accepted Implementation Plans, and

11. Congress and the President be notified of the shortfall in accordance with statutory requirements.

John T. Conway
Chairman