DEFENSE NUCLEAR FACILITIES SAFETY BOARD

RECOMMENDATION 94-1

IMPLEMENTATION PLAN

FEBRUARY 28, 1995

DNFSB Recommendation 94-1
Implementation Plan
February 28, 1995

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Section 1: Executive Summary

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

The measures outlined in this plan to stabilize nuclear materials constitute an important part of an integrated management process to address these urgent issues. As an interim measure until permanent organizational issues are addressed, the Department has established the Nuclear Materials Stabilization Task Group, to specifically address the stabilization of nuclear materials. This Task Group will integrate activities across the sites and the material categories, making the most efficient use of the complex's facilities, and will examine methods and alternatives for improving practices and schedules as this effort progresses.

The Department has 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.

This Implementation Plan is organized into two major sections:

- **Organization and Management** - Details the systems engineering approach and responsibility and the formation of the Nuclear Materials Stabilization Task Group for ensuring the Department achieves the commitments detailed in the Implementation Plan. An Integration Working Group (IWG), composed of technical representatives from key sites, will support and report to the Task Group for purposes of ensuring the best integration of materials stabilization between sites. A Research Committee (RC) will support and report to the Task Group on research and technology development needs for the integrated stabilization program.

- **Materials** - Organizes materials by types; that is: plutonium solutions, plutonium metals and oxides (greater than 50 wt.%), plutonium residues and oxides (less than 50 wt.%), special isotopes, certain uranium, and spent nuclear fuel. Each material discussion provides the overall plans and timelines for stabilization activities across the complex.

The commitments, proposed actions and anticipated proposals contained herein are summarized below. In most cases, the Department meets the time periods recommended by the Board for conversion and placement in safe, secure storage of the material. In cases where the recommended time frame cannot be met, compensatory measures to ensure safety have been, and will continue to be taken until all such materials are in a safe and suitable form. Other actions are being considered which would result in the acceleration of stabilization activities. Many of the committed actions, proposed actions and anticipated proposals are contingent upon Environmental Impact Statements and other studies that have not yet been completed. The completion dates noted in this Implementation Plan are based on the assumption that anticipated preferred alternatives of the studies will be selected. In the event a situation arises that presents an imminent hazard to workers, the public, or the environment, the Department will take whatever action is necessary to mitigate the risk.

Summary of Departmental Commitments to DNFSB Recommendation 94-1

Sub-recommendation (1):

That an integrated program plan be formulated on a high priority basis, to convert within 2-3 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.

Commitment:

This Implementation Plan is the integrated program plan. It provides the schedules and major milestones in each material category for achieving the recommended objectives. It will be modified by future program direction and schedule adjustments.

All separated plutonium metal and oxide will be repackaged to meet the metal and oxide storage standard by May 2002. A trade study will be completed by May 15, 1995, that will consider factors such as risk to workers and public, radiation exposure to personnel, waste minimization, discharges to the environment, cost impacts, and impact on other activities. The results of this study may determine that in some cases the schedule could be shortened, while in others the factors may argue for a longer schedule.

Sub-recommendation (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 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 (1) above.

Commitment:

By March 1995, a Research Committee will be established to define, coordinate and monitor research and technology development efforts to support nuclear material stabilization activities and to ensure a core of technology development activity exists to support nuclear material stabilization. By November 1995, the committee will have assessed current research and technology development efforts against complex-wide nuclear material stabilization needs, identified areas where initial research and technology development efforts are to be strengthened, and presented this analysis to the Nuclear Materials Stabilization Task Group in a comprehensive research and technology development plan. Research and technology development efforts will be measured against the comprehensive plan, which will be annually updated.

Sub-recommendation (3):

That preparations be expedited to process the dissolved plutonium and trans-plutonium 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.

Commitment:

A stabilization method for the Savannah River Site F-Canyon has been selected and stabilization of plutonium solutions began in February 1995 and will be completed by January 1996. A conceptual design report for the stabilization of americium/curium solutions will be completed by December 1995. All americium/curium solutions will be stabilized by September 1998. Other solutions, not specifically mentioned in this recommendation but addressed in this plan, will be stabilized in accordance with the following schedule:

Pu solutions in PUREX (Hanford)	August 1995
HEU Solutions (Rocky Flats)	December 1996
Pu-242 solution in H-Canyon (Savannah River Site)	November 1997
HEU Solutions (Savannah River Site)	December 1997
Pu solutions in PFP (Hanford)	January 1999
Pu solutions (Rocky Flats)	June 1999
Pu-239 solution in H-Canyon (Savannah River Site)	February 2000
Neptunium solutions in H-Canyon (Savannah River Site)	December 2002

Sub-recommendation (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.

Commitment:

All plutonium metal in direct contact with plastic will be repackaged by September 1996. Plutonium metal in proximity to plastic will be repackaged when the capability exists for meeting the Department's storage standard, unless surveillance detects containers requiring immediate repackaging.

Sub-recommendation (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.

Commitment:

Higher risk residues at the Rocky Flats Environmental Technology Site will be stabilized as follows:

Vent 2,045 residue drums with potential hydrogen build-up	October 1995
Vent inorganic residues and wet/miscellaneous residues	October 1996
Bulk (6,000 kgs) of high-hazard pyrochemical salts	May 1997
High-hazard sand, slag, and crucible and graphite fines	May 1997
Remainder (4,000 kgs) of high-hazard pyrochemical salts	December 1997
High-hazard combustibles	November 1998
Repackage inorganic oxides and wet/miscellaneous residues	May 2002

Residues at other sites, not specifically addressed in this recommendation will be stabilized according to the following schedules:

Pu Residue Sludge at Hanford	September 1995
220 kgs of residues at Los Alamos National Laboratory	October 1995
46 Packages of Ash at Hanford	March 1996
Sand, slag & crucibles at Savannah River	December 1997
Ash residues at Lawrence Livermore National Laboratory	April 1998
All other residues at Hanford	May 2002
All other residues at Savannah River	May 2002

Sub-recommendation (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.

Commitment:

The method for stabilizing fuel and targets at the Savannah River Site will be selected by July 1995 pursuant to the Interim Management of Nuclear Materials EIS and ROD. Fuel storage basin water chemistry upgrades will be completed by May 1996. Contingent upon the outcome of the Interim Management of Nuclear Materials EIS, targets will be stabilized via dissolution by September 1996; fuel dissolution will be completed by November 1999. Stabilization of resultant uranium solutions will be completed by April 2000.

Sub-recommendation (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.

Commitment:

Fuel and sludge removal from K-Basins will be completed by December 1999. Interim measures have and will be taken including installing a cofferdam between the K-East Basin and the reactor discharge chute by April 1995. Fuel and sludge characterization in hot cells will begin by April 1995.

Sub-recommendation (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.

Commitment:

Sufficient capabilities will be retained to maintain future handling, treatment and safe storage of the materials addressed in this plan. A discussion of facilities currently in use or planned for use is included in Section 2.6. The facilities section of the Integrated Program Plan will be prepared by December 1995.

Sub-recommendation (9):

Expedited preparation 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.

Commitment:

Facilities will be started or restarted in accordance with DOE Order ~~5480.31.~~ 425.1 These restart and start-up requirements will be taken into account in the development of the facilities section of the Program Plan.

Section 2: Organization and Management

2.1 Background

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 designed, handled, and packaged for short-term storage; therefore, when the weapon production lines were halted in the late 1980's, many materials were left in conditions unsuitable for long-term storage.

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

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

- *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)*

The *Spent Fuel Working Group Report* identified significant vulnerabilities causing the Department to study alternative programmatic solutions (i.e., a Programmatic Spent Nuclear Fuel Environmental Impact Statement). The final study is scheduled for issuance in April 1995 with a Record of Decision planned for June 1995.

The Defense Nuclear Facilities Safety Board (DNFSB) noted in Recommendation 94-1 in May 1994, and supporting staff reports in April 1994, that the halt in production of materials used in nuclear weapons froze the manufacturing pipeline in a state that, for safety reasons, should not be allowed to persist unremediated. The DNFSB noted special concern about specific liquids and solids containing fissile materials and other radioactive substances in spent fuel storage pools, reactor basins, reprocessing canyons and various facilities once used for processing and weapons manufacture.

The Departmental assessments identified above and the independent observations and concerns expressed by the DNFSB 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 an increasing concern.

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

These issues are growing more serious as evidenced by this Implementation Plan. The Department is strongly committed to marshalling the resources to stabilize its nuclear material safely.

Key Assumptions

In order to achieve the high-level commitments outlined in the Executive Summary, there are several underlying assumptions identified for each of the material categories presented in Section 3. These key assumptions include:

- Environmental and other studies will be used to develop alternatives; selection of an alternative will be made through Records of Decision. For most of the materials described in Section 3, the decisions made pursuant to the NEPA process are assumed to be consistent with the options described such that the milestone dates can be achieved. The NEPA process is a key element of DOE's planning process and the principal means of achieving stakeholder involvement.

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

- The highly enriched uranium and plutonium contained in solutions/metals and oxides/residues/mixed oxides and spent nuclear fuel will be identified in the plan.

Key Challenges

To achieve the objectives outlined previously several categories of challenges (i.e., potential barriers to progress) have been identified. These represent a roll-up of the material-specific challenges and barriers. These challenges include:

- Maintaining material handling, treatment, and storage capabilities. This involves compensating for using facilities beyond their nominal design life (aged facilities) and maintaining adequate personnel with the necessary critical skills while the Department undergoes personnel and budgetary cutbacks.

- Developing and implementing standards for handling, storing, and transporting nuclear materials, including a uniform risk classification scheme, that are compatible with as yet undeveloped disposition criteria.

- Developing and applying actions to rapidly remediate unacceptable conditions while ensuring necessary and sufficient compliance with applicable regulations and statutes including the NEPA. This may involve negotiation with applicable state, national and international regulatory agencies.

- Researching and developing technologies and processes needed in order to progress toward disposition of certain classes of nuclear materials including certain categories of plutonium residues and spent nuclear fuel.

2.2 Integration and Management Method

Progress of the Department's nuclear material stabilization activities will be monitored through the site plans described below and compared with the Integrated Program Plan. The need for management action will be identified in part through this comparison with the site plans, which will be updated monthly.

Integrated Program Plan (IPP): This Implementation Plan is the baseline IPP called for by Recommendation 94-1. The Plan addresses the stabilization of the material categories identified in Figure 2.2-1, and will be modified by program decisions or as schedules change due to changes in program requirements. Planned additions to the IPP are sections that address complex-wide requirements for technology research and development that will be developed by the Research Committee and the long range facility requirements section, to be developed by the Integration Working Group.

Site Integrated Stabilization Management Plans (SISMPs): The SISMP documents the activities for the nuclear material categories at each site in response to the objectives and requirements of the IPP. They will also contain a specific subsection, a Facilities Plan (FP) that will discuss what facilities and facility capabilities will be used to undertake the site-wide stabilization activities. The SISMPs will be updated in response to program direction and to document changes in schedule.

Nuclear Material Stabilization Task Group
Implementation Plan Material Categories

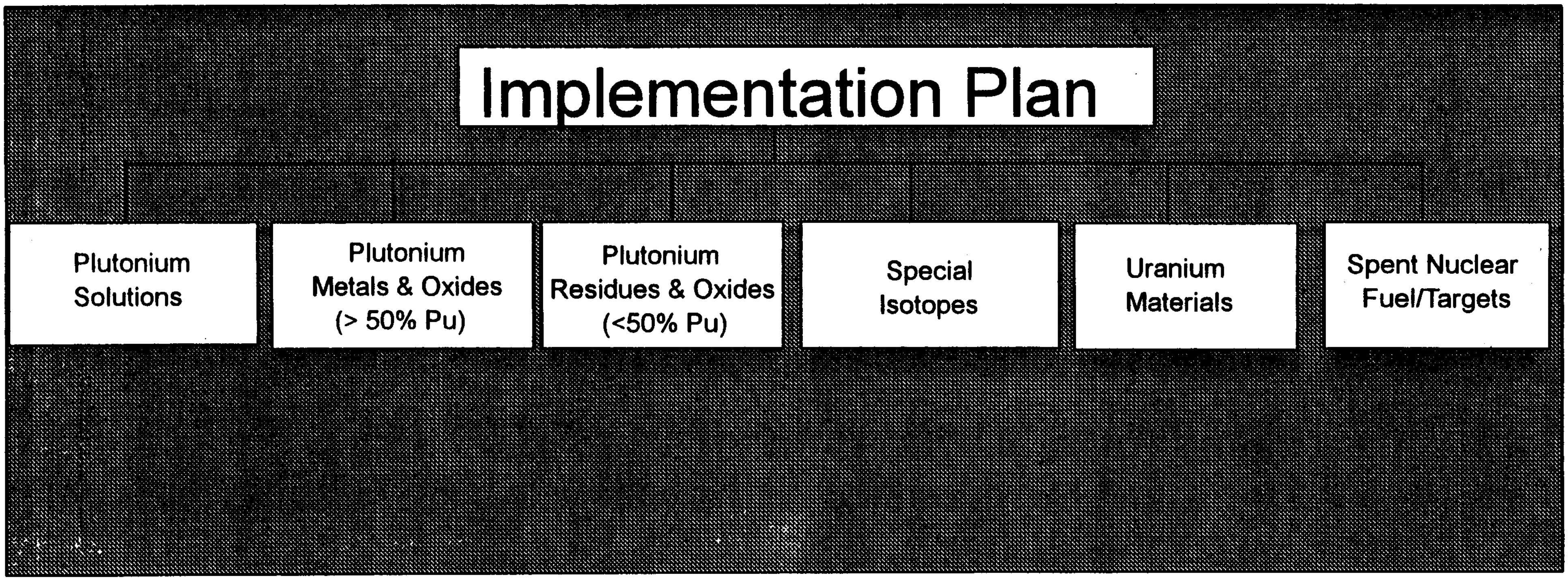


Figure 2.2-1

Integration of Spent Nuclear Fuel related activities has been underway using a similar process. Section 3.6 provides greater detail. This SNF process will be modified to more closely align it with the process developed to address the other material categories. Specifically, the SNF Program Plan will be structured to account for those commitments and required activities promulgated by the IPP. The SNF Program Plan will be provided to the Task Group to facilitate tracking and reporting of commitments and milestones.

The basic systems engineering process that will be applied to develop the technical solutions for stabilizing nuclear material is illustrated in Figure 2.2-2. This process is designed to ensure the Department's priority and standards for stabilizing nuclear material are reflected in well structured, integrated programs. Throughout this process the Task Group will be guided by the following high-level objectives:

- Manage the program through consistent Departmental strategies.
- Integrate facilities, capabilities and priorities throughout the program.
- Base programmatic decisions on a clear understanding of the problem, the definition of goals or end-state, and analysis of alternative paths that takes into account, as a minimum, the following issues:
    - Limiting worker exposure.
    - Minimizing generation of additional waste.
    - Minimizing emission of effluent to the environment.
    - Avoiding the generation of mixed waste.
- Assess the corporate effort and identify:
    - Future processing facility and storage capacity needs.
    - Consolidation opportunities.
    - Cost efficiencies available through technology development and application, and inter-site cooperation.

2.3 Project Approach

Specific activities that the Task Group will use to plan, develop and monitor activities are illustrated in Figure 2.3-1. Activities related to each material category will be scheduled and accomplished with a series of decisions, development phases, and products. Output from these activities will include:

- Early project definition with clear description of desired end-state.
- Quantifiable assessments of alternative options (trade-off studies).
- Quantitative measurement of progress through the use of Performance Measures with Schedule and Performance Baselines.
- Auditable records of key programmatic decisions and issues.
- Clear identification of organizational responsibility for Headquarters and Field organizations.

Basic Systematic Approach for Nuclear Materials Stabilization

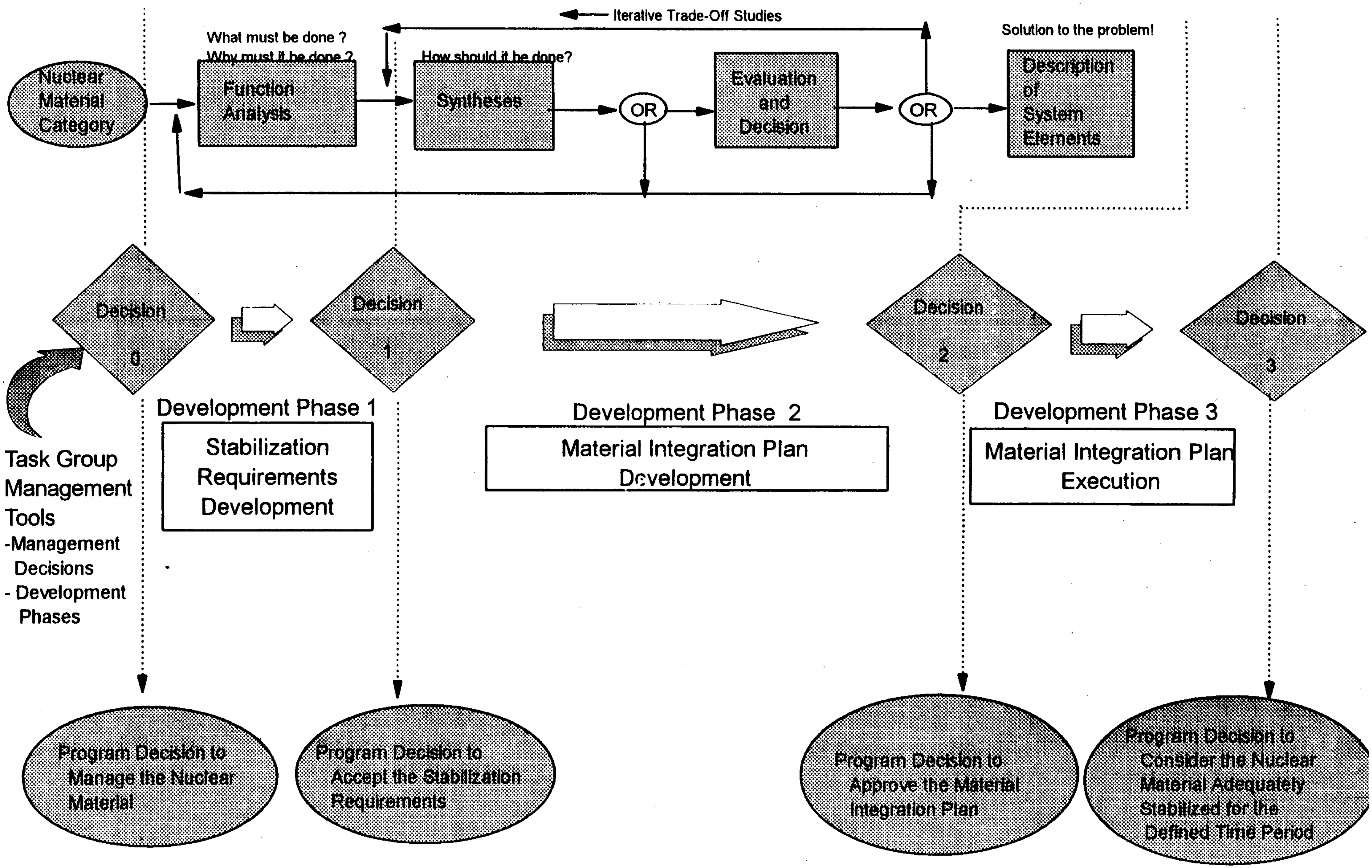


Figure 2-[illegible]

The process displayed in Figure 2.3-1 can be tailored by the Task Group to be more responsive to program management requirements and to integrate the activities required to develop, evaluate, and select programmatic alternatives. On a case-by-case basis, a distinct decision may be made in development Phase 2 to select an alternative in conjunction with appropriate NEPA analysis. Both programmatic and site-specific NEPA analysis, as appropriate, and RODs will be formally incorporated into the program planning process.

Each material category presented in Section 3 of this Implementation Plan contains three major parts:

Part	Contents
I	Requirements
II	Material Integration Approaches
III	Individual Site Activities

This format was developed to clearly illustrate the integrated, material based approach taken to structure stabilization activities. Site activities, proposals and anticipated proposals, are scheduled to accomplish the overall Departmental objectives.

The ongoing individual site activities are delineated to illustrate the fact that stabilization activities are already in progress, albeit not yet part of an integrated Departmental effort.

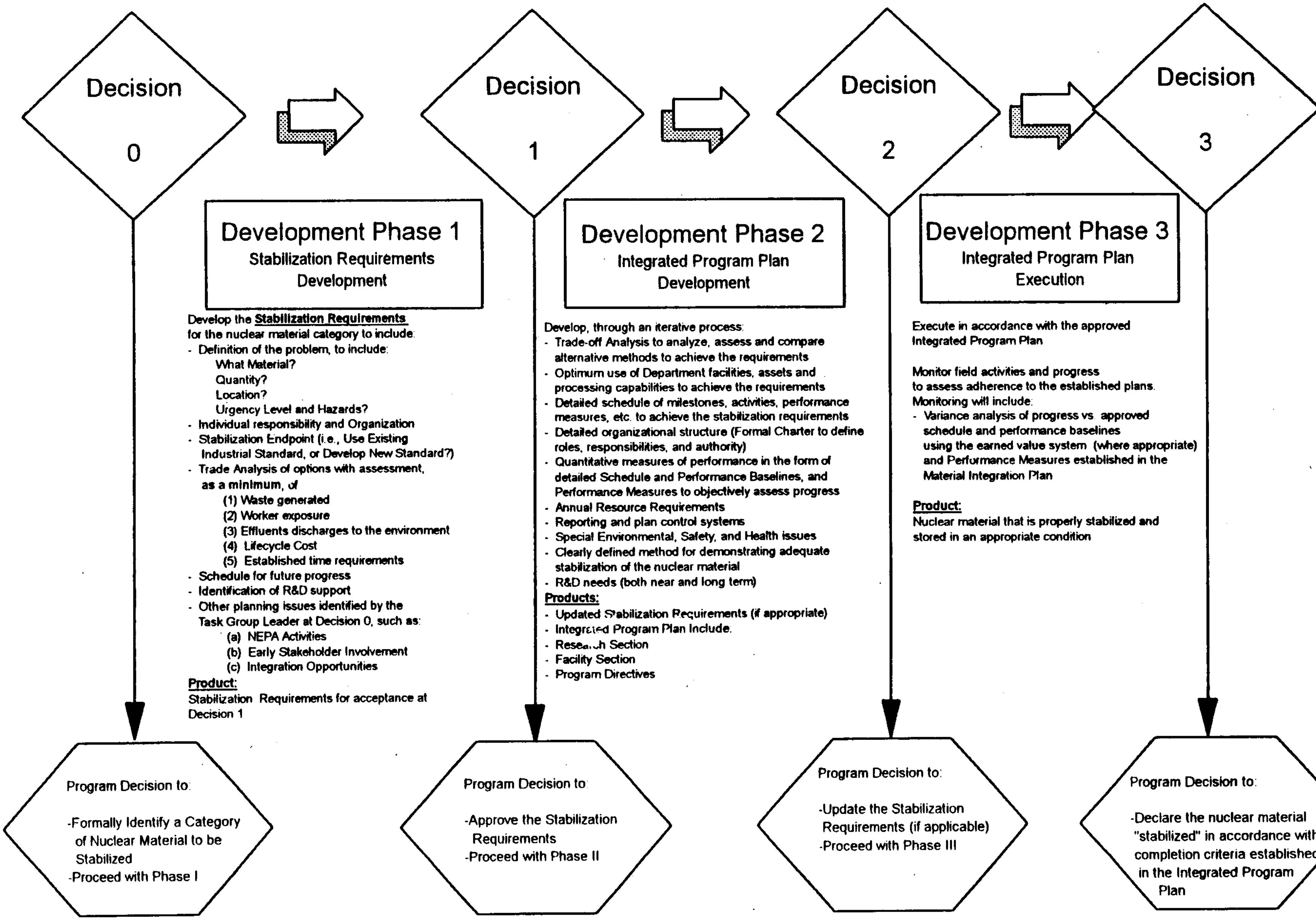
2.4 Organization

The Department is committed to stabilizing the materials identified in Recommendation 94-1 in conjunction with correcting the vulnerabilities identified in the Plutonium Vulnerability Assessment and the Spent Nuclear Fuel Vulnerability Assessment. The Department's Strategic Alignment Initiative currently in progress is considering organizational changes appropriate to the issues. For the present, a Nuclear Materials Stabilization Task Group will be established to report within the Department of Energy organization as illustrated in Figure 2.4-1.

The Task Group will provide the integration structure for the management of material stabilization. The goal of integration is to use the most effective means to achieve the desired material end-states, not necessarily uniformity of approach to stabilization at all sites. Different site-specific approaches may be acceptable.

Coordinated efforts to manage Department-owned Spent Nuclear Fuel have been underway for some time. In responding to Recommendation 94-1 it is important continue these efforts, but with appropriate modifications to ensure prompt resolution of the Board's concerns with minimal duplication of efforts. The responsibilities of the affected organizations are described below to address these concerns.

Stabilization Integration Process



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In November 1994, an Integration Working Group was formed with representation from the sites, headquarters, and the contractors. This group has met twice to develop a data base of available facilities and to identify initial opportunities for integration. A technology workshop took place at the Rocky Flats Environmental Technology Site (RFETS) to discuss research and development initiatives focused on high priority residues. This workshop resulted in action plans for stabilizing residues at Rocky Flats. This group will be continued as described in Section 2.5.2.

2.5 Organization and Functions

2.5.1 Nuclear Materials Stabilization Task Group

The mission of the Nuclear Materials Stabilization Task Group is to integrate the Department's programs for stabilizing excess nuclear materials to achieve safe, stable states for interim and long-term storage pending disposition. With respect to DOE-owned Spent Nuclear Fuel, the Task Group will be responsible for monitoring those issues explicitly identified in Recommendation 94-1 and for reporting any schedule variances, and their impacts on commitments, to the Under Secretary.

To accomplish this mission, the Task Group will have the following responsibilities:

- Provide, through the Under Secretary, program direction and policy for the integrated management of the stabilization of nuclear materials.
- Designate materials within the scope of the project.
- Form and direct an Integration Working Group that will identify and evaluate stabilization requirements, capabilities, operational barriers, and integration opportunities.
- Direct the research and technology development needed to support the project.
- Form and direct a Research Committee (RC) that will identify research and technology requirements, evaluate proposals for addressing requirements, and prepare appropriate task directions for laboratory work.
- Develop the research and facilities sections of the Integrated Program Plan and other reporting vehicles necessary to monitor progress. Control changes to the Integrated Program Plan.
- Determine the facilities, capabilities and critical skills to be maintained and the length of maintenance.
- Direct trade studies necessary for determining preferred alternatives for treating and storing the materials included in the program.

luclear Materials Stabilization Task Group

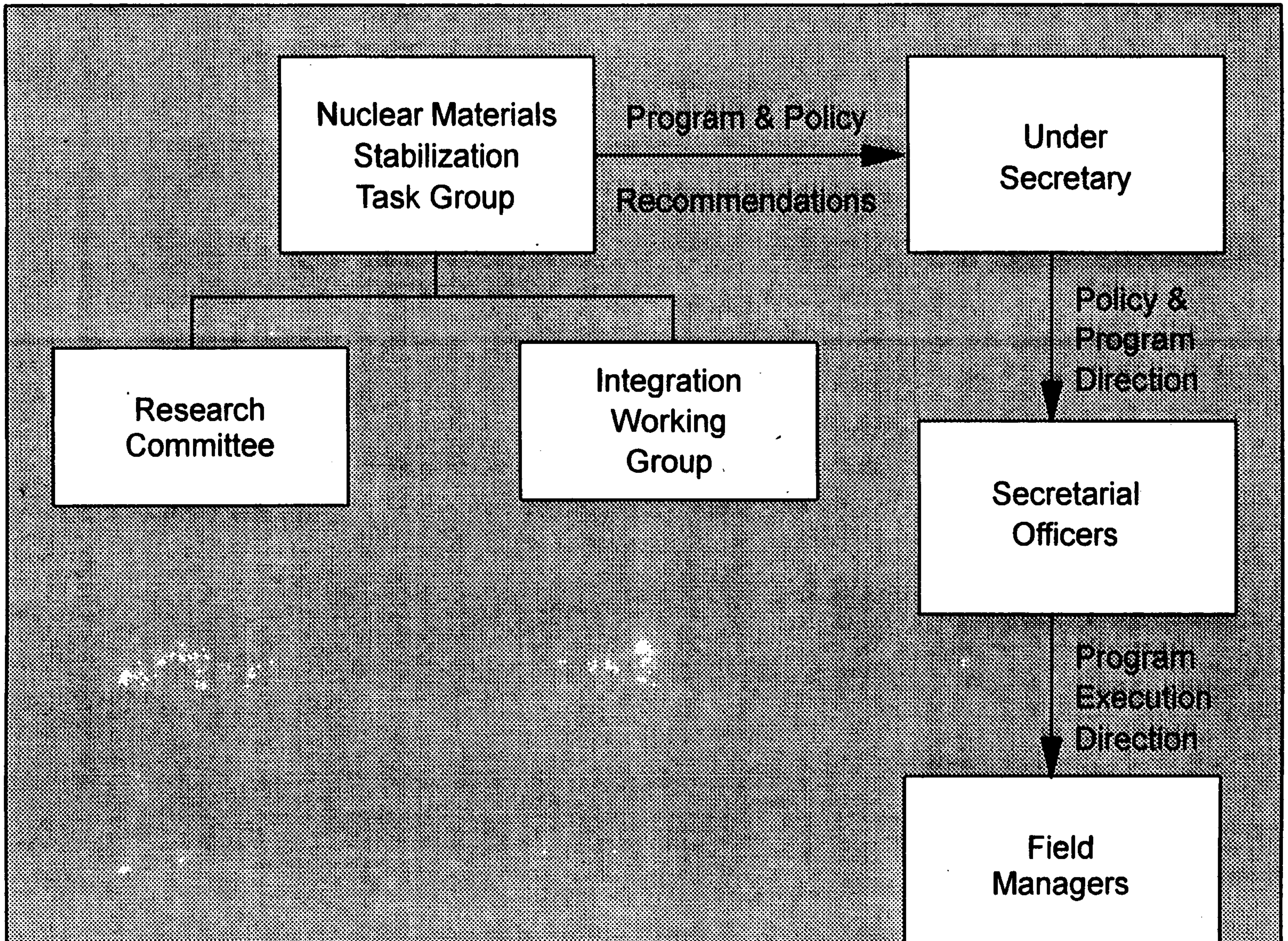


Figure 2.4-1

- Advise senior line managers of schedule variances and their impacts on commitments and progress to desired end-states, and recommend appropriate management action.

- Initiate the development of standards and procedures needed for the program.

- Report quarterly to the Under Secretary the progress of the Department in implementing the Integrated Program Plan, recommending appropriate actions to address funding or progress shortfalls.

- Initiate reports to the Defense Nuclear Facilities Safety Board on changes to milestones in the Implementation Plan for the Board's Recommendation 94-1, and an annual report to the Board on the progress toward meeting the commitments in the Implementation Plan.

2.5.2 Integration Working Group

The Integration Working Group will be responsible to the Task Group for the following:

- Identifying, recommending, and coordinating support tasks related to the integration of material activities among multiple sites, using focus teams as required to define requirements for specific actions and issues;

- Developing a database of material stabilization needs for each site and the capabilities that exist at all sites that may be usable;

- Performing trade studies on alternative treatment and storage strategies, using Systems Engineering as a tool for evaluating quantitative and qualitative benefits and costs, especially options for intersite transfers of materials;

- Assessing the current inventory of treatment, processing, and storage facilities; their capabilities, maintenance and other requirements, and the sum of the materials to be treated, to produce a long-range plan for facilities required for their program; and

- Identifying options and program recommendations for dealing with materials at smaller sites.

2.5.3 Research Committee (RC)

The committee will established by March 15, 1995 and will be responsible to the Task Group for developing a Research and Development Plan to address short and long term needs for the program.

2.5.4 Interfaces

A number of non-direct-line organizations within DOE have responsibility for issues associated with nuclear materials management and stabilization that will directly relate to the activities described in this Implementation Plan. The Task Group will ensure that all related activities are integrated and coordinated to prevent duplication of effort and conflicting actions. The potential synergies resulting from the integration of technologies, capabilities (facilities), and materials will be missed if the Task Group "stovepipes" planning by material categories. Therefore, an overarching integration strategy will be developed and implemented through the effective interaction among the Task Group, materials program officials, the Integration Working Group, and the Research Committee. Specific examples of related organizations include the following:

- The Office of Waste Management (EM-30) through the Spent Nuclear Fuel Management Group (EM-37) is responsible for the complex-wide management of DOE-owned spent nuclear fuel including the resolution and management of all issues and commitments delineated in this Implementation Plan. Policy and budgetary guidance, including the associated planning and execution documentation, to affect complex-wide integration of spent nuclear fuel activities remains the responsibility of this office. Communication will be initiated and maintained with the Task Group to ensure an accurate status of activities to resolve issues raised by Recommendation 94-1.

- The Office of Technology Development (EM-50) is responsible for conducting all technology development efforts for the Office of Environmental Management.

- The Office of Fissile Materials Disposition (MD) is responsible for assessing and developing departmental recommendation for long-term storage of all weapons usable fissile materials and for disposition of those weapons-usable fissile declared surplus to defense needs by the President. The office if also responsible for directing implementation of the resulting decisions. is

- The Office Strategic Planning and Policy (EM-4) is leading a department-wide Materials in Inventory (MIN) effort to assess all nuclear materials in DOE that are no longer in use.

- The Office of Civilian Radioactive Waste Management (RW) is responsible for establishing waste acceptance criteria for certain categories of nuclear wastes and managing the disposition of civilian spent nuclear fuel.

- Office of Environment and National Defense (PO-9) is responsible for coordination with applicable material management policies and initiatives.

2.6 Facility Readiness

Operational Readiness

Recommendation 9 stated, *"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."*

It is the Department's policy that the start-up of new or restart of existing facilities will be in accordance with the requirements of DOE Order 5480.31. This order defines the requirements for the scope and depth of readiness reviews prior to start-up and the appropriate approval levels for the start-up activities. It also defines the prerequisites required before the readiness review is conducted, the appropriate level of independence of the readiness review team, and the role of the Department's independent oversight of the readiness review activity.

For each facility/operation identified for use through this Implementation Plan and in the Material Integration Plans, the application of the appropriate requirements of DOE Order 5480.31 will be applied as facilities are restarted or new facilities are started up.

Future Use of Facilities

Recommendation 8 stated, *"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."*

Many of the materials covered by this Recommendation will remain in safe interim storage for long periods before their final disposition. During this period some of the materials may have to be handled, treated, or repackaged. Therefore, certain facilities and capabilities throughout the complex must be retained to ensure that repackaging or other treatment can be performed when required.

The Integration Working Group will submit to the Task Group by December 1995 a recommended long range facilities plan. This plan will consider the entire range and quantities of materials to be stabilized, repackaged, treated for interim and long-term storage; existing and planned facilities and their readiness and capacity. When approved, this plan will become part of he Integrated Program Plan.

Because of aging Departmental facilities and the long time periods that may be involved, DOE Standard DOE-STD-1073-94, Guide for Operational Configuration Management Program (Including the Adjunct Programs of Design Reconstitution and Aging Management), will be used to guide the management of such facilities.

The following is a list of facilities that are being, are or are currently planned to be used to stabilize and/or store materials. For the purposes of this Plan, the list is merely a point of departure from which the long-range plan will be developed.

Facility	Material	Function
SAVANNAH RIVER		
K/L/P Reactor Disassembly Basins	Spent Fuel and Targets	Pool Storage (until Processed)
Receiving Basin for Offsite Fuels (RBOF)	Spent Fuel and Targets	Pool Storage and Ion Exchange Resin Regeneration
F-Canyon	Plutonium Materials Spent Fuel/Targets Special Isotopes	Processing Am/Cm Vitrification
FB-Line	Plutonium Materials	Solutions, residues and scrap stabilization
H-Canyon	Plutonium Materials Spent Fuel/Targets Special Isotopes	Processing
HB-Line	Uranium and Plutonium Materials Special Isotopes	Solutions, residues, and scrap stabilization
SRTC Bldg. 772 F	All Types	Analytical Chemistry
SRTC Bldg. 235 F and 247 F	Plutonium Materials	Storage
ROCKY FLATS		
Bldg. 371	Pu Metal and Oxides Pu Residues Pu Solutions	Storage Thermal Stabilization Repackaging Residue Processing
Bldg 886	Uranium Solutions	Drain and Blend Solutions
Bldg 771	Plutonium Solutions Plutonium Residues Plutonium Metal and Oxide	Stabilization Storage

Facility	Material	Function
Bldg 707	Plutonium Metal and Oxide Pu Residues	Repackaging Oxide Thermal Stabilization Storage Repackaging Some processing
Bldg 779	Pu Metal Pu Residues	Storage Repackaging and/or processing
Bldg 776/777	Pu Metal Pu Residues	Storage Repackaging and/or processing
Bldg 559	Pu Samples	Analytical Chemistry
Bldg 774	Low concentrated Pu Solutions	Solution Processing
LOS ALAMOS		
TA-55	Various Pu forms	Processing
CMR	Various Materials	Analytical Chemistry, Uranium
TA-50	Various Uranium and Pu forms	Liquid Waste Treatment
TA-54	Various Uranium and Pu forms	Solid Waste Management
HANFORD		
Conditioning Facility	Spent Fuel/Sludge	Fuel/Sludge Conditioning
Bldgs 324/325/327 Hot Cells	Spent Fuel/Sludge	Characterization and stabilization process development
PFP	Pu Materials	Stabilization
Canister Storage Building	Spent Fuel/Sludge	Storage

Facility	Material	Function
INEL		
CPP-666 Fuel Storage Area	Spent Fuel	Storage (fuel awaiting dry storage), Processing
CPP-749 Dry Storage Wells (New Generation)	Spent Fuel	Dry Storage of Spent Fuel
OAK RIDGE		
ORNL Bldg 7503	Molten Salt Reactor Materials (MSRE)	Stabilization
ORNL Bldg 3525 Hot Cell	MSRE	Material Conversion
Y-12 Bldg 9212	HEU	Chemical Processing, Casting, and Packaging,
LAWRENCE LIVERMORE		
B 332 Plutonium Facility	Pu Metal, Pu Oxide, Pu Residue Processing	Processing, Stabilization, Repackaging, Storage

2.7 Integrated Research and Technology Development

2.7.1 Background

Research and technology development on actinide materials, particularly uranium and plutonium, was extensive during the 1945-1990 time period. This work was generally mission oriented (nuclear weapon and power reactor fuels) but a substantial effort was devoted to fundamental research. As a result, the Department possesses an extensive fundamental chemistry and metallurgy data base on high purity uranium and plutonium. In contrast to the data base on high purity materials, the knowledge base for the behavior of residues is woefully inadequate. Most scrap residues and materials that were generated during plutonium and uranium metal preparation and machining were packaged and stored without being characterized. The packaging standards were *ad hoc* or nonexistent and inconsistent among the various DOE sites. The Department has recently published long-term storage criteria for plutonium metal and characterized plutonium oxide. However, a technical basis does not exist to develop adequate standards for characterization, treatment, and safe storage of nonoxide and nonmetal materials in residues throughout the complex. Residues, as well as other processing intermediates, are now stored at several sites under conditions that cannot assure safety.

With increasing frequency, the complex is experiencing unexpected and unsafe behavior from various materials in storage such as excessive generation of hydrogen gas, container pressurization, generation of pyrophoric materials that threaten ignition and spread of radioactive contamination, and leakage from containers of radioactive solutions. Clearly corrective actions are needed. However, concerning residue storage, an adequate knowledge and technology base does not exist. Research and technology development is needed to resolve both near-term and long-term problems.

2.7.2 Objectives

DNFSB Recommendation 94-1 defines the research objective as:

"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."

To achieve this objective a research and technology development program with two elements is needed:

- A technology-specific program that is focused on treating and storing materials safely, with concomitant development of storage criteria and surveillance requirements, centered around the 3- and 8-year targets.
- A core technology program to augment the knowledge base about general chemical and physical processing and storage behavior and to assure safe interim nuclear material storage, until disposition policies are formulated.

2.7.3 Approach

The research program will consist of two elements: a technology-specific research program and a core technology development program. The technology-specific research program will consist of near-term tightly focused efforts. The core technology program will focus on overarching long-term problems and can be viewed as a combination of three research areas: 1) continuation of technology-specific research and technology development, 2) development of new applications for existing technologies, and 3) development of new technologies for old and new problems.

Many of the near-term uranium problems are less serious than those involving plutonium. Uranium research and technology development needs will be assessed as the program is developed. Resource levels will be identified when the Research and Development program is developed.

Los Alamos National Laboratory will be the lead laboratory for research and development for the plutonium metals and oxides, residues, and solutions material categories. Research and Development for uranium, and special isotopes material categories will be competed among the National Laboratories.

Research and technology development efforts are underway to support the placement of spent fuel into safe, secure interim storage. The coordination of these efforts is achieved through the Technology Integration Technical Working Group established by the Office of Spent Fuel Management in June 1993. A Technology Integration Plan, SNF-PP-FS-002, was issued in December 1994. This plan delineates and details all planned and proposed technology development activities needed to support the spent nuclear fuel program.

2.7.3.1 Specific Research

Examples of the types of research needed and ongoing research are as follows:

Packaging of Various Materials for Interim Storage

Many materials are not sufficiently characterized to allow prediction of behavior in storage. Moreover, safe package designs have not been developed to a significant extent. These short-comings could be eliminated by development of sampling and analytical procedures, more effective processing methods and a storage package surveillance/demonstration program. This work should also build on the knowledge and experience gained in the metal and oxide characterization and repackaging activities. A need exists for surveillance of the stored material whether it is metal, oxide or a stabilized residue. To the extent that packaging can be consistent among these material forms, these surveillance requirements should be simplified.

A specific R&D plan, for developing standards for residues storage at Rocky Flats and Los Alamos, is being executed jointly by those organizations. This project will characterize residue items and containers, establish criteria and surveillance procedures and define storage container qualifications.

Solutions

R&D on the problem of solution stabilization is limited to the development and demonstration of relatively simple processes. Precipitation of Rocky Flats plutonium solutions can be used as an example. Development will proceed using either oxalate or hydroxide as a precipitating agent. These are processes that have been used routinely around the complex for years. Deployment of the process at Rocky Flats is expected in FY95.

Equipment Design and Automation

While not necessarily a processing/stabilization technology, the design of equipment and the judicious use of automation can enable the implementation of technologies.

variety of efforts are currently underway which fit into this category. Examples include the development of bagless transfer systems by Savannah River Technology Center, Sandia National Laboratory and Los Alamos, dustless transfer equipment being developed by Lawrence Livermore National Laboratory and numerous other efforts. Personnel risks are increased by the presence of excessive dusting during stabilization operations.

The ability to implement stabilization technologies may be limited by the ability to authorize facilities for various operations. The design of equipment and containment with the specific goal of lessening the facility safety basis requirements will allow more rapid deployment of stabilization technologies. Ancillary operations such as vacuum, cooling water and off-gas scrubbing and filtration systems could be built into the specific operational equipment. This approach would not require that these systems be operational for the entire facility before any operations can be implemented within a building.

2.7.3.2 Core Technology Programs

Although the fundamental chemical and physical data base to support weapons production and nuclear fuel development is comprehensive, new requirements for EM's mission call for a better understanding in some unexplored areas. For example, factors controlling the specific surface areas of plutonium oxides prepared by various methods are unknown. Additionally, the adsorption of many gases on the oxides and the radiological effects that can cause package pressurization or package degradation are poorly understood. We can predict with only limited confidence the rates of helium release as plutonium ages for very long times.

A core technology program can be viewed as a combination of three research areas: 1) continuation of specific research and development, 2) development of new applications for existing technologies, and 3) development of new technologies for old and new problems. The boundaries between these areas are flexible. Some of the research areas that should be studied are discussed below.

<u>Combustibles</u>

Combustible items are very difficult to manage. The best solution for these wastes is likely simple incineration. It is, however, very difficult or impossible to obtain a permit in today's environment. Oxidizing this waste by advanced means such as electrochemical or hydrothermal processing could be investigated. Near term solutions to this problem are being investigated through some joint Rocky Flats/Los Alamos efforts. Several processes will be demonstrated on a small scale to allow selection and development of the best method.

Pyrochemical Salts

Pyrochemical salts have been identified as one of the residue categories requiring stabilization. The issues include reactivity of the halide metals such as sodium, reactivity of metallic plutonium, and potential hydrolysis from the adsorption of atmospheric moisture. An R&D program is currently underway focused on the development, demonstration and transfer of process technology to Rocky Flats that will be used to stabilize reactive salt residues.

Unique Feeds

Numerous residue categories have never been processed by the Department. Examples include plutonium contaminated graphite and certain plutonium alloys. Flow sheet development and small scale demonstration of competing processes will be needed to select a preferred processing option.

2.7.4 Development of the Research and Development Plan

The Research Committee mentioned in Section 2.5.3 will be responsible to the Task Group for:

- Assessing the stabilization program for research and technology needs, current and planned research and development efforts appropriate to the stabilization program, and commercially available technologies that are directly applicable

- Formulating a research and development plan for the program that addresses both the technology-specific and the core elements

- Preparing task statements that define the work that the lead laboratories are expected to perform in order to accomplish the objectives

- Evaluating proposals from the laboratories

2.7.5 Milestones and Commitments

Research Committee Established . . . . March 15, 1995

Research Section of the IPP . . . . November 1995

2.8 General Issues

2.8.1 Relationship to Plutonium Vulnerability Assessment

In March 1994, the Secretary of Energy commissioned a comprehensive assessment to identify and prioritize the environmental, safety, and health vulnerabilities that arise from the storage of plutonium in Department of Energy facilities and determine which are the most dangerous and urgent. These vulnerabilities include degradation in plutonium materials and packaging, and weaknesses in facilities and administrative controls that can result in inadvertent releases of plutonium to which workers and the public may be exposed, or that may contaminate the environment. This DOE-wide assessment identified 299 environment, safety, and health vulnerabilities of which 91 related to degradation of materials and packaging, 140 relate to facility inadequacy or degradation and the remainder to institutional problems.

Most of the materials and packaging vulnerabilities are specifically covered or encompassed by the intent of DNFSB Recommendation 94-1. Many of the facility vulnerabilities, if left unattended, might preclude the safe use of facilities for future handling and treatment of the materials, which must be stabilized and stored. Because of the interrelation between the Recommendation and the Plutonium Assessment, the Task Group will monitor the actions being taken to address the vulnerabilities identified in the Plutonium Vulnerability Assessment.

A similar relationship exists between Recommendation 94-1 and the SNF Working Group Report; essentially, the 94-1 issues represent a subset of the deficiencies identified in the SNF Working Group Report. The Office of Waste Management will monitor the corrective actions associated with both documents, reporting progress related to Recommendation 94-1 to the Task Group as necessary.

2.8.2 Impact of Presidential Decision Directive 13 on Stabilization

The United States does not encourage the civil use of plutonium and, accordingly, does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purposes. The proposed processing activities are necessary to alleviate immediate and urgent environmental, safety and health concerns associated with the shutdown of reprocessing in the Department's weapons complex. These management efforts will not undermine broader U.S. nonproliferation efforts that are focused on stemming the buildup of plutonium stocks in the civil nuclear fuel cycle. Further, the Secretary of Energy has prohibited the use for nuclear explosive purposes of the Pu-239 or highly enriched uranium arising from these reprocessing activities.

2.8.3 Impact of International Inspections on Stabilization

In his September 27, 1993, nonproliferation statement, the President said that the United States would submit United States fissile material no longer needed for our deterrence to inspection by the International Atomic Energy Agency. The President also proposed a multilateral convention prohibiting the production of highly enriched uranium or plutonium for nuclear explosives or outside international safeguards — a fissile material cutoff treaty. The United States has signed an agreement with Russia prohibiting the use of newly produced plutonium for weapons. This agreement also calls for the negotiation of a bilateral total ban on the production of plutonium for nuclear weapons. The Department has established a close liaison with the Departmen of State regarding the implementation of these nonproliferation efforts.

Each of these nonproliferation commitments entails varying levels of verification that over time will have an important impact on the application of safeguards within the Department's complex. Although plans are still under development to fulfill these commitments on an interagency basis, the Department expects that for the next severa years these nonproliferation commitments will largely affect storage facilities for separated fissile materials. As a result, the application of multilateral or bilateral safeguards is not expected to create schedule delays for stabilization activities requirec by this implementation plan.

Section 3: Materials

3.1 Plutonium Solutions

Part I: Stabilization Requirements

3.1.1 General Overview

Background

Approximately 412,000 liters of Pu-239 solutions exist throughout the DOE complex, primarily at Rocky Flats, Savannah River, and Hanford. These plutonium nitrate and chloride solutions were in the process of being converted to a purified plutonium metal or oxide at the time of shutdown, or in facility process system hold-up.

Site	Type of Material	Plutonium Kg	Quantity	Location
Rocky Flats	Pu-239 Solutions	143	30,000 liters	Bldgs 371,559, 771, 776/777, 779
Savannah River Site	Pu-239 Solutions	Classified	354,000 liters	F-Canyon H-Canyon
Hanford	Pu-239 Solutions	358	4,800 liters	Plutonium Finishing Plant
	Pu-239 Solutions	9	22,700 liters	PUREX

Overview of Concerns

Plutonium nitrate and chloride solutions are currently being stored in configurations that were not designed for extended storage. The solutions are stored in plastic bottles, plastic lined tanks, stainless steel bottles and tanks, and process piping. These solutions, which range in concentration from 0.25 to 300 grams of plutonium per liter, represent some of the most significant vulnerabilities to the worker, but pose a low risk to the public or the environment. There is no question that solutions are not suitable for safe interim storage and must, therefore, be solidified.

Leaking solutions pose the first area of concern. Solutions stored in plastic bottles Rocky Flats and Hanford can become brittle due to radiolysis and acid reactions, anu have leaked in the past. Hanford stores plastic bottles in stainless steel cans, which can degrade and leak if the plastic bottles fails. Corrosion of tanks and piping used for extended storage of acidic solutions at Rocky Flats and Savannah River is also of concern because of potential for leaks in the tanking system gaskets, seals and welds.

An additional area of concern is related to hydrogen generation. Radiolysis will attac the organic storage containers generating a hydrogen gas. Hydrogen generation in unvented containers will increase the pressure on the storage container resulting in an increased rate of embrittlement and leakage. This ultimately leads to a fire and explosive hazard due to hydrogen gas buildup.

A lower likelihood but higher consequence related to solution storage is criticality. Solution storage configurations were designed to prevent criticality through geometrical shapes, administrative controls to limit plutonium concentrations, or the use of boric acid or raschig rings as neutron absorbers. However, unanticipated high local plutonium concentration due to plutonium precipitation could lead to criticality. This concern primarily applies to solutions stored in tanks.

Applicable Sub-recommendations from DNFSB Recommendation 94-1

Sub-recommendation 1:

> *That an integrated program plan be formulated on a high priority basis, to convert within two to three years the materials addressed in specific recommendations below to forms or conditions suitable for safe interim storage*

Sub-recommendation 3:

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

Sub-recommendation 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.*

Acceptance and Objectives

DOE agrees with the importance and urgency to place these materials in a safer configuration, and is committed to completing the stabilization as expeditiously as possible. A significant portion (85%) of the materials will be stabilized within three years, with the remaining solutions being stabilized within an additional two and one-half years. DOE has established the following objectives:

- Minimize the likelihood and consequence of accidents through effective surveillance, compensatory measures, and responsive emergency actions.
- Stabilize all solutions as expeditiously as feasible.
- Place plutonium metal and oxide generated from stabilizing these solutions in a form suitable for safe interim storage by May 2002.
- Minimize waste generated from the stabilization activities and packaged to meet the appropriate waste acceptance criteria.

Key Assumption

- The outcomes from the NEPA process will be consistent with the options used to develop these schedules.

Part II: Plutonium Solution Integration Activities

Approach

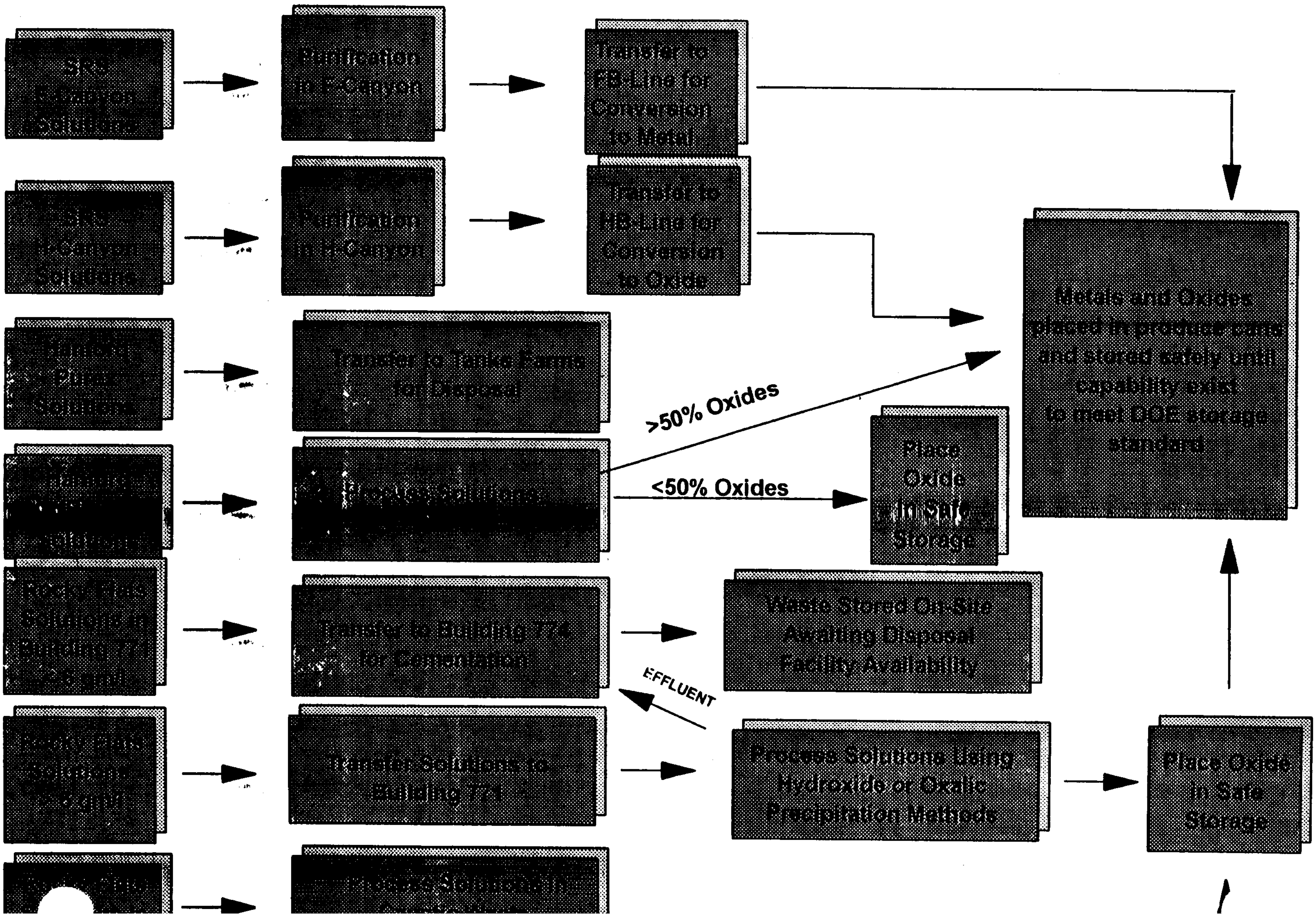
The goal for the solutions across the complex is: to stabilize them as expeditiously as possible.

Complex-wide integration is necessary for technology transfers, establishing similar goals, and sharing lessons learned. Further integration, i.e. transferring solutions to another site for processing, is severely restricted by the current regulations. Regulation 10 CFR 71.63 states, "Plutonium in excess of 20 curies per package must be shipped as a solid." Intra-site integration is also essential between liquid stabilization activities and obtaining the capability to place metal and oxide in safe interim storage. Effective integration of these activities may reduce the need to handle the materials twice, thus avoiding unnecessary radiation exposure. Typical material stabilization activities are noted on Figure 3.1-1.

The key functions required to place the solutions in safe stable storage are as follows:

- Establish and implement compensatory measures to reduce the likelihood and/or consequence of accidents, while awaiting stabilization.
- Characterize solutions to maintain safety and to prepare for upcoming stabilization activities.
- Stabilize solutions and place in safe temporary storage.
- Monitor the packages to ensure continued safe storage.

Plutonium Solutions Stabilization



- Package the plutonium metal and oxides (>50% Pu) generated from the stabilization process to meet the requirements of DOE-STD-3014-94.

Key Challenges

- Utilizing aged facilities to stabilize the solutions.
- Maintaining the expertise needed to operate the facilities.

In recognition of these challenges, activities will be initiated to:

- Review budget requests to ensure the appropriate level of maintenance, training, and staffing in facilities are appropriate required for future stabilization or safe storage.
- Monitor site activities to ensure schedules are maintained and recommend alternatives to shorten the schedule, when appropriate.

Part III: Individual Site Activities

3.1.2 Plutonium Solutions at Rocky Flats

Solutions are present in Buildings 371, 559, 771, 776/777, and 779, with the majority being in Buildings 371 and 771. The solutions at are stored in plastic bottles, tanks and pipes. While awaiting stabilization, several interim measures have been taken to minimize the risks of continued storage. The plastic bottles are being transferred to gloveboxes where they can be vented to decrease the rate of degradation and inspected to identify incipient failures in time to replace the bottles. Access to areas where the potential for leakage from tanks or pipes is strictly controlled. Alarm systems are in place to detect airborne contamination from spills or leaks, and alert personnel. Piping system flanges and valves have been encased in plastic shrink wrap to provide an additional barrier between the solutions and the workers.

Rocky Flats conducted the Actinide Solution Disposition Study to evaluate the different process and location options. The study concluded that the safest, least expensive, and quickest option was to utilize existing processes in Buildings 371, 374, 771, and 774 to precipitate the high-level solutions and cementing other low-level solutions. Higher-level solutions at Rocky Flats are defined as greater than 6 grams of plutonium per liter. Low-level solutions are defined as less that 6 grams of plutonium per liter.

The following disposition plans will depend on the Environmental Assessment resulting, if appropriate in a Finding of No Significant Impact (FONSI), with the proposed action being selected. The NEPA analysis is scheduled to be completed in April 1995.

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

All solutions stored in Buildings 559, 776/777 and 779 will be transferred to Building 771. Low-level solutions in Building 771 will then be transferred to Building 774 for cementation. Cementing the low-level solutions began in October 1993 and to date 1500 liters have been solidified. The high-level solutions will be processed in Building 771 using a hydroxide (for chloride solutions) and oxalate (for nitric solutions) precipitation method. The precipitate will be calcined and placed in temporary storage awaiting safe interim storage. The effluent will be transferred to Building 774 for cementation or further processing in carrier precipitation. All solutions in Building 771 will be stabilized by December 1997.

The solutions in Building 371 will be treated in the Caustic Waste Treatment System, which is a hydroxide precipitation process. The precipitate will be calcined and pla in safe interim storage. The effluent will be transferred to Building 374 for process through carrier precipitation. The solutions in Building 371 will be stabilized by June 1999.

The liquid stabilization program will be integrated with current efforts to meet the saf storage criteria, DOE-STD-3014-94 for oxides in an effort to minimize handling the precipitates. However, the liquid stabilization activities will not be delayed to achieve this integration. The oxide, generated prior to obtaining the capability to meet the criteria in DOE-STD-3014-94 will be packaged to meet site storage requirements.

3.1.3 Plutonium Solutions at the Savannah River Site

The Pu-239 solutions are located in the F- and H- canyons at Savannah River. Until the solutions are stabilized the major area of concern is control of solution chemistry. Due to evaporation and radiolysis, solution chemistry requires continuous adjustments to avoid unanticipated concentration or precipitation of boron and ultimately the plutonium compounds, which may increase the potential for inadvertent criticality. Boron was added as a neutron poison and solution chemistry is adjusted to avoid precipitation of the boron and ultimately the plutonium. An increased sampling and surveillance program is in place to detect signs of deterioration. Minor leaks and spill are not a major concern since they will be contained within the canyons and fed back into the tanks without exposing the workers or posing a risk to the environment or public. Corrosion of tanking cooling water coils pose a risk of environmental relea

F-Canyon solutions pose a more significant concern than H-Canyon solutions since the volume of Plutonium solutions in F-Canyon is an order-of-magnitude more than H-Canyon and exists in a wide variety of tanks and chemical conditions.

The Record of Decision for the F-Canyon plutonium solutions was issued on February 2, 1995. The options considered for the Pu-239 solutions in the F-Canyon included no action, process to plutonium metal, process to plutonium oxide, and vitrification. The selected option was to operate F-Canyon to purify the solutions and transfer them to the FB-Line for conversion to metal. The stabilization of F-Canyon plutonium solutions began on February 3, 1995 with an expected completion of January 1996.

The plutonium metal produced from the FB-Line will be packaged to site storage standards (e.g., inside a produce can, bagged in plastic. and packed in an outer produce can) for temporary storage in one of the F-Area vaults. The metal will require repackaging to meet the DOE storage standard when the new safe interim storage containers, packaging capability, and new or modified vault storage becomes available. The processes and operations required represent routine operation of facilities which have been operated successfully for over 40 years. F-Canyon second plutonium cycle has been restarted. The FB-line Operational Readiness Review is complete and resolution of findings is in progress.

The Interim Management of Nuclear Materials (IMNM) EIS will identify a preferred alternative for stabilization of the Pu-239 solutions in the H-Canyon. The options considered for the solutions in the H-Canyon are no action, conversion to a low-fired oxide in H-Canyon and HB-Line, transfer to high-level waste tanks for vitrification in the Defense Waste Processing Facility (DWPF), vitrify in F-Canyon, process to metal in F-Canyon, and continued storage of these solutions under active management.

The proposed action is to process the solution in H-Canyon to remove decay products and other material that would interfere with subsequent stabilization steps followed by transfer of Pu-239 to HB-Line Phase II for conversion to a low-fired oxide. Should this proposed option be selected, the plutonium oxide will be placed in temporary storage until the capability exists to meet the DOE storage standard. The ROD for the EIS is planned to be issued in July 1995. If the stabilization in H-Canyon proposal is selected, stabilization operations will begin in February 1999, and completed by February 2000 for the Pu-239 solution in H-Canyon.

HB-Line Phase II start-up has been scheduled for early 1999 to allow for continuous operation to complete three campaigns: Pu-239 solution, mixed plutonium-uranium oxides and neptunium solutions. This schedule will coincide with the availability of new packaging and storage facilities for the resulting neptunium oxide. Safety of continued storage of the H-Canyon plutonium solutions until stabilization is complete has been enhanced through additional sampling and monitoring activities.

3.1.4 Plutonium Solutions at Hanford

The solutions at Hanford are located in PUREX and the Plutonium Finishing Plant (PFP). Until stabilization of the solutions in PFP is complete, interim measures will remain in effect to minimize the risk to the worker, public and environment. By September 1995, all bottles will be inspected to ensure proper venting. The solution are stored in vault-type rooms restricting unnecessary worker access. Air in the storage rooms is exhausted through a filtered system. To guard against sparks, every container is electrically grounded and only non-sparking tools are used to open the containers. Additionally, procedures require the workers to wear protective clothing and respirators during any activity that involves opening containers. The solution stored in PUREX are within a canyon protecting the workers, public, and environme from contamination risk.

The Plutonium Finishing Plant contains approximately 4,800 liters of plutonium bearing nitrate, chloride, and organic solutions. The 220 liters of chloride solutions will be stabilized by September 1995, during the developmental testing program.

The Hanford site has committed to its stakeholders to conduct an Environmental Impact Statement (EIS) on its clean-out and stabilization activities to assure proper environmental considerations are provided for all processes utilized during these activities. There are several technologies being evaluated for stabilization of these solutions. However, the technology selection will depend on the results of the developmental testing program and the outcome of the EIS. A Record of Decision is expected in June, 1996. Since direct denitration avoids a liquid waste stream and do not purify its product, two points important to Hanford stakeholders, it was the technology chosen to determine the schedule in this plan. The product from the dire denitration process will be an oxide with varying plutonium concentrations, some are expected to be below 50%. The resulting oxide will be suitable for temporary storage but for oxides greater than 50% Pu additional processing and packaging steps are required to meet the criteria in DOE-STD-3014-94. If direct denitration is the approach chosen from the EIS and ROD, the start-up of a direct denitration system could be started in June 1997, following procurement and installation of the producti scale system. The stabilization of all solutions is scheduled to be completed by January 1999.

PUREX had approximately 22,700 liters of solution containing 9 kgs of plutonium ar 5 metric tons of uranium. A systems engineering study was conducted to determine the best approach to disposition these solutions. The preferred approach from the December 1993 study was to neutralize and dispose the solutions into the double-shel waste tanks at the tank farms. Transfer to the tank farms was initiated in June 1994, and is expected to be completed by August 1995. To date approximately 13,000 liter have been neutralized and transferred to the tank farms.

3.1.5 Key Milestones

The following is list of the key milestones for stabilizing Pu-239 solutions. This is not intended to be an all encompassing list of milestones, but rather milestones that can be used as a rough measure of progress.

Rocky Flats:

Began cementing low concentrated solutions in Building 774 .... October 1993

Complete NEPA process .... April 1995

Stabilize 80% of high-level solutions and
50% of low-level solutions (18,000 liters) .... May 1997

Stabilize all solutions in Building 771 .... December 1997

Stabilize all solutions in Building 371 .... June 1999

Savannah River Site:

F-Canyon:
- ROD issued for F-Canyon Plutonium Solutions EIS .... February 1995
- Began F-Canyon processing operations .... February 1995
- Convert 320,000 liters of solutions to metal .... January 1996

H-Canyon:
- ROD issued for Interim Management of Nuclear Materials EIS .... July 1995
- Begin H-Canyon processing operations .... February 1999
- Convert 34,000 liters of solutions to oxide .... February 2000

Hanford:

Plutonium Finishing Plant (PFP) solutions:
- ROD issued for PFP Clean-out and Stabilization EIS .... June 1996
- Complete technology development .... March 1996
- Begin processing solutions .... June 1997
- Complete processing 4,800 liters .... January 1999

PUREX solutions:
- Began transfer to tank farms for disposal .... June 1994
- Complete transfer of 22,700 liters to tank farms .... August 1995

3.2 Plutonium Metals and Oxides (> 50% assay)

Part I: Stabilization Requirements

3.2.1 General Overview

Background

The DOE currently manages over 14 metric tons of plutonium metal and oxide, whicl are not adequately packaged for long-term storage. Also, DOE manages over 6,000 sealed weapon components, principally stored at the Pantex Plant, containing plutonium. In general, the metal and oxide exists in several grades and forms, and ar packaged in a multitude of configurations, most of which were prepared a number of years ago and are not suitable for interim, let alone long-term storage. The weapon components include assembled units retired from the National Nuclear Weapons Stockpile, which are not included within this implementation plan. Other special unit such as those manufactured for "shelf-life" studies, and special development orders are included in this plan. Some of these will require processing for long-term storage. Tables 3.2-1 and 3.2-2, respectively, summarize the quantities of plutonium metals an oxides currently in inventory at the various facilities in need of repackaging.

Table 3.2-1: Plutonium Metals

Site	SNM Inventory (kgs)	Number of Items	Location(s)
Rocky Flats	6,600	3,403	371, 559, 707, 771, 776/ 777, 779, 991
Hanford	700	350	PFP**, PNL*
Los Alamos	1,133	2,000	TA-55, CMR, TA-18
Savannah River	Classified	450	FB-Line, 235F, SRTC
Argonne-West	***	***	ZPPR, FMF, 752
Argonne-East	0.45	210	205, 212, 315
Lawrence Livermore	20	250	B 332
Mound	0.855	20	T, SW\R
Oak Ridge	0.3013	30	3027, 3038, 5505
Sandia	6.7	5	NMSF

* PNL has 254 packages of metal/oxide/residues.
** PFP has about 2,850 items containing plutonium metals and oxides.
*** The major holding are about 2,600 containers of metals/oxides.

Table 3.2-2: Plutonium Oxides (> 50 % Assay)

Site	SNM Inventory (kgs)	Number of Items	Location(s)
Rocky Flats	3,200	3,296	371, 559, 707, 771, 776/777, 779, 991
Hanford	1,500	2,500	PFP**, PUREX, PNL*
Los Alamos	721	2,000	TA-55, CMR, TA-18
Savannah River	Classified	550	FB-Line, HB-Line. 235-F, SRTC
Argonne-West	***	***	ZPPR, 752, FMF
Argonne-East	0.48	695	200, 306, 315
Lawrence Livermore	102	154	B 332
Mound	28.132	107	T, SW\R
Oak Ridge	1.706	83	3027, 3038, 5505, 7920, 7930, 9204-3
Sandia	1.4	354	HCF, ACRR, NMSF
Lawrence Berkeley	0.014	10	70, 70A, 70-147A

* PNL has 254 packages of metal/oxide/residues.
** PFP has about 2,850 items containing plutonium metals and oxides.
*** The major holdings are about 2,600 containers of metals/oxides.

Additional materials will be generated at processing sites from the stabilization of other material forms.

Overview of Concerns

Plutonium metal and oxide will require extended storage for many years while awaiting the long-term disposition option that will be determined through the Nuclear Material Disposition PEIS. Most of the plutonium stored in the DOE complex is in metal form. The most significant ES&H vulnerabilities from the storage of plutonium metal stem from oxidation and radiolysis. Package failure can result from either normal oxidation or hydride-catalyzed oxidation. Current packaging configurations can allow air and moisture to enter, resulting in normal oxidation. When a container of plutonium metal also contains plastic bags or a food-pack can with synthetic material seals, the plastics and synthetic materials degrade. Oxidation of plutonium metal within existing storage containers presents the potential for breach of containment since the volume of the formed plutonium oxide is observed to be about 2 1/2 times greater than the metal. Radiolytic and/or thermal reactions between the metal and plastics, moisture, and/or synthetics can also result in the formation of gases that can react with the plutonium to form pyrophoric plutonium hydride; and/or directly lea containment failure via expansion or pressurization. Several plutonium metal contai failures at LANL, other DOE sites, and in the United Kingdom emphasize the need t repackage the metal as well as note metal oxidation buildup.

The DOE has over 5 metric tons of plutonium in the form of plutonium oxide. The most significant vulnerabilities from the storage of plutonium oxide stem from radiolysis, pyrophoricity, and dispersibility. Oxide stored in proximity to plastic packaging can result in failures similar to those associated with metal. Pressure generated from radiolysis (1) or thermal reactions with plastic or absorbed moisture (can cause gas buildup and contribute to plutonium releases. In general, since plutonium oxide is a fine powder, it poses a significant hazard relating to contamination incidents. Since it is also respirable, it poses unique hazards for workers. In addition, oxides generated by the corrosion of metal may contain metal fines and small amounts of hydride, both of which are pyrophoric.

The combinations of material and packaging configurations that require more urgent treatment include the plutonium metal in direct contact with plastic and the partially oxidized oxide (pyrophoric or reactive oxide). The section below summarizes the DO approach to dealing with these materials, and specifically defines the materials in this category as well as the basis for priority actions.

Applicable Sub-recommendations from DNFSB Recommendation 94-1

Sub-recommendation 1b:

> *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 plutonium now being made final* (NOTE: The DOE standard, DOE STD-3013-94, for packaging plutonium metal and oxide was issued December 1994.)

Sub-recommendation 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 or 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.*

Acceptance and Objectives

DOE concurs with the DNFSB recommendations and has established the following objectives:

- Assure safe storage conditions are maintained through surveillance and monitoring activities until processing to a safe storage state can be achieved.

- Repackage all plutonium metal in direct contact with plastic by December 1995.

- Material in close proximity to plastic will undergo periodic sampling, surveillance and monitoring and repackaging those forms or packaging configurations where problems are found on a priority basis.

  - The term "in proximity to plastic" means that direct communication between the plutonium and the plastic is possible (i.e., there is no airtight container separating them).

- Repackage all separated plutonium metal to meet the metal and oxide storage standard by May 2002.

  - Perform a trade study by May 1, 1995 that will examine the requirement to complete this activity for all sites by 2002. The study will consider factors such as risk to workers and public, radiation exposure to personnel, waste minimization, discharges to the environment, cost, and impact on other activities. Based upon the results of the study, the Department may propose an alternate schedule for certain sites.

- Thermally stabilize the backlog of all known reactive plutonium oxide by May 1997.

- Thermally stabilize and repackage all plutonium oxide to meet the metal and oxide storage standard by May 2002.

- Subject materials to a formal ongoing surveillance program as they are packaged and placed in storage.

  - The surveillance program will be developed from research currently underway at Los Alamos.

- Contingent upon appropriate NEPA analysis, transfer the metal and oxide between sites as a means of minimizing the number of sites required to place plutonium metal and oxide in safe interim storage.

Key Assumptions

- The DOE Plutonium Metal and Oxide Storage Standard (DOE STD-3013-94) will be used throughout the complex to meet the 8-year milestone for the storage of metals and oxides (>50 % assay).

- An integrated research and development program will be launched to develop the technologies to overcome current technical uncertainties and shortcomings such as design and manufacturing of a long-term storage container; packaging and stabilizing materials in accordance with the metal and oxide storage standard; interim and long-term surveillance needs; and, long-term storage behavior of metals and oxides.

- Interfaces with the Office of Fissile Material Disposition, Agreement for Mutual Reciprocal Inspections, and/or International Atomic Energy Agency (IAEA) Safeguards will be integrated. Issues include material form, packaging configuration, and term and capacity of storage.

- Metals and oxides in active programs or research and development inventories will be excluded in addition to "retired" weapon components from this implementation plan.

Part II: Plutonium Metal and Oxide (>50% Assay) Integration Activitie

Approach

A complex-wide integrated approach will be pursued so that the most technically sound approaches will be used for similar materials independent of site; inter-site transfers will be considered for sites having insufficient capabilities or capacity; and, barriers to integration will be evaluated based on risk and cost. Strategies will be explored to enhance present on-site commitments, as well as options to consolidate repackaging and storage to a minimum number of sites by the Integration Working Group. The approach is shown in Figure 3.2-1, Metal and Oxide Stabilization. One specific integration opportunity is related to plutonium in close proximity to plastic; where each site is approaching this issue in a slightly different manner.

Functions required:

- Compensatory surveillance and monitoring activities to assure safe storage conditions are maintained.

- Priority repackaging of plutonium metal in direct contact with plastic, or synthetic materials.

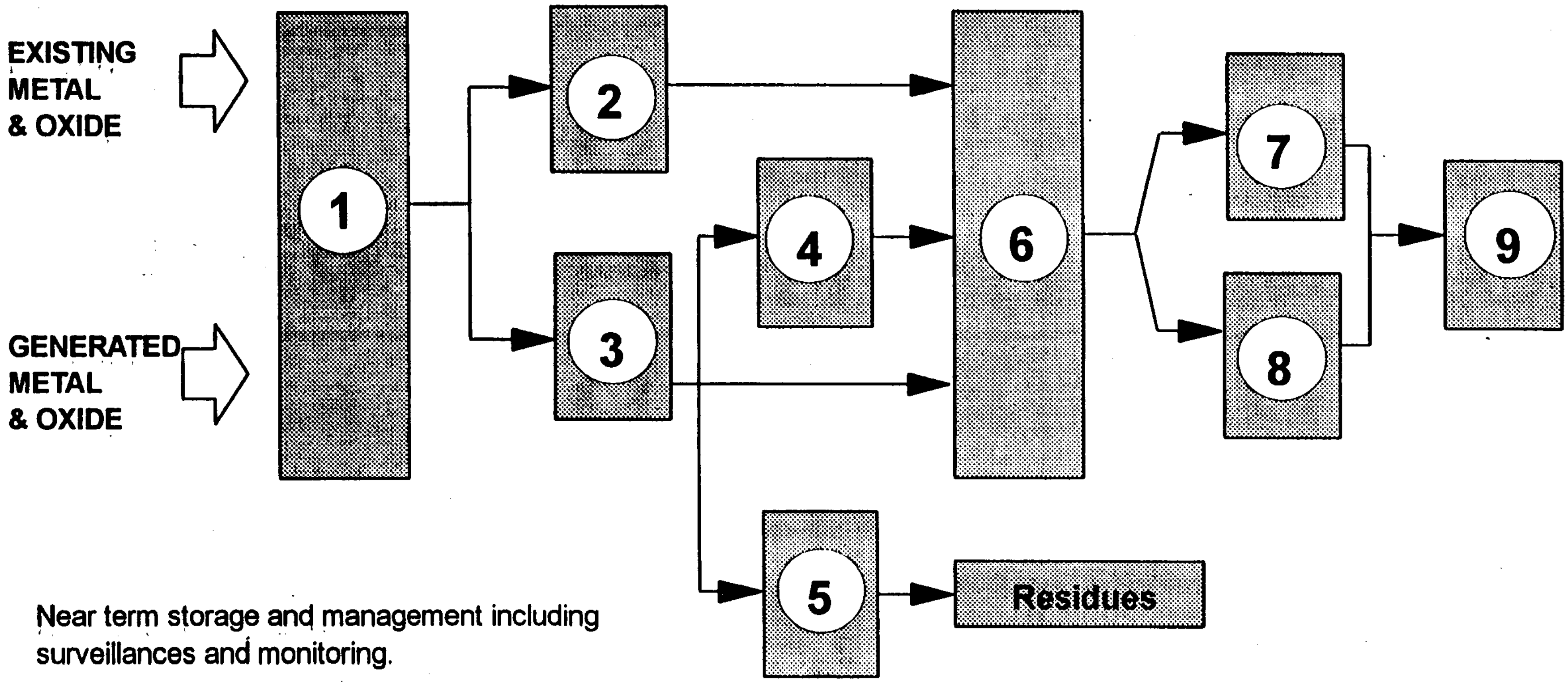
- Priority thermal stabilization of reactive plutonium oxide.

- Priority repackaging of plutonium in close proximity ; plastic (and other synthetic materials).

- Characterization required to select and prioritize items for treatment.

- Interim storage and emergency repackaging.

Metal and Oxide Stabilization



1 Near term storage and management including surveillances and monitoring.

2 Repackaging known hazards (e.g., metal in direct contact with plastic, reactive oxides, etc.) on site storage standards.

3 Characterization to select and prioritize treatment.

4 Stabilization and repackaging as required to meet the site storage requirements.

5 Transfer to "residue" category if standard cannot be met via

6 Management to site storage standards.

7 Ship to alternate stabilization and repackaging facility to meet DOE's storage standard.

8 Stabilize and repackage to meet DOE's storage standard.

9 Safe interim storage

Figure 3.2-1

- Stabilization and repackaging to meet the metal and oxide storage standards (including the facilities required).
- Packaging and shipment for sites without storage, stabilization, or repackaging capabilities.

Key Challenges

- Improved material characterization, container design, surveillance, and handling techniques are needed to reduce operator exposure, minimize waste, control processes, and assure a safe long-term storage configuration.
- Integrated strategy to simultaneously support processing, storage, transportation and disposition needs.
- Acceptable packaging and shipping capability that meets Department of Transportation (DOT) requirements.
- Stable long-term profile of the material.

In recognition to these challenges, activities will be initiated to focus on improving th efficiency, resource expenditure and time required to achieve the repackaging of containers holding plutonium metal and oxide (>50% assay) by:

- Developing standard requirements for the surveillance and maintenance activities associated with the inventory.
- Developing a technically adequate storage container for safe long-term storage
- Developing a single strategy for transporting plutonium metal and oxides (>50% assay) within the Department.

Part III: Individual Site Activities

3.2.2 Implementation Approach for Rocky Flats Plutonium Metals and Oxides

Several activities have been or are being implemented at Rocky Flats to reduce the ris associated with plutonium metals and oxides until they can be placed in a form suitable for safe interim storage. The material has been consolidated into vaults with access limited to essential personnel equipped with protective clothing and respirators. Movement of containers is strictly controlled. The vaults are constructed with air monitors, alarms, and ventilation systems that are designed to minimize the spread of contamination and protect the worker.

A monitoring and surveillance program detects degradation of storage conditions. Containers are periodically visually inspected as specified by site requirements (i.e., Health Safety Practices HSP 31.11; material control and accountability inventories, radiological surveys, etc.) to look for anomalies. A representative sampling of the repackaged material containers are weighed to determine if weight gain is within the allowable limits to prevent the container from breaching due to oxidation of the plutonium metal.

There are 1,858 items of plutonium metal that are not in compliance with on-site storage requirements. Compliance is necessary prior to placing these items in a form that can meet the metal and oxide storage standard. A representative sampling of plutonium metal (i.e. various forms, packaging configurations, alloys, etc.) is essentially complete, enabling prioritization for bringing these items into compliance. The highest priority has been placed on the metal that is packaged in direct contact with plastic. The 256 items in this storage configuration will be repackaged by October 1995. Repackaging operations are conducted in Building 707 and consist of opening the container, brushing the loose plutonium oxide from the metal, thermally stabilizing the oxide, and repackaging the metal so that it is not in direct contact with plastic. The remaining items requiring repackaging will be repackaged by October 1996 on a priority basis from the results of sampling. The oxides generated from brushing the plutonium will be thermally stabilized at a minimum of 500°C to eliminate the pyrophoric characteristics of the oxide; and then repackaged.

A new processing line is required to place the metal and oxide in a form that meets the metal and oxide storage standard for safe interim storage. This line is planned to be operational in FY98 upon installation in Building 371. The processing line will require a furnace to thermally stabilize the oxides to less than 0.5% loss on ignition and oxidize all plutonium metal with a surface area greater than 1.0 cm^2/g; the capability to brush loose oxide from metal; repackaging the material in the newly designed safe interim storage container; and, nondestructive assay capabilities. The conceptual design for this line has begun.

Rocky Flats' metal inventory includes material in sealed weapon components (pits) and what is known as "non-weapons reserve units" that are not of weapons quality (i.e., "shelf-life" units, special order units, partially disassembled units, etc.) that have various tubulations or material configurations that do not provide the packaging integrity required for long-term storage. All such pits are being considered for shipment to a laboratory for disassembly with stabilization and repackaging of the plutonium to the metal and oxide storage standard. Scrub alloy, an alloyed button of plutonium and americium from the scrubbing of salts from the molten salt extraction process, will be considered for shipment to Savannah River for processing in F-Canyon. Processing of scrub alloy at Savannah River allows the americium to be extracted to the high-level waste processing system, and the by-product metal to be packaged to the long-term storage standard.

3.2.3 Implementation Approach for Savannah River Plutonium Metals and Oxides

Savannah River has approximately 1,000 containers of high purity plutonium solids stored in F-Area vaults. Each container holds at least 100 grams of fissile material that is predominantly Pu-239 with minimal impurities. The stored material includes alloys, compounds, oxides, and large metal pieces. Savannah River had accumulated these high grade plutonium solids as a result of both F-Area facility operations and shipments received from other DOE sites. These materials were stored in a variety o containers within F-Area vaults and present extended storage concerns because of thei physical condition. The degree of concern varies depending on the material form and packaging configuration. Additionally, approximately 200 containers of high quality metal and oxide will be produced from the stabilization of solutions, targets, and residues and will also require packaging and treatment to meet the metal and oxide storage standard. The objective is to ensure that all plutonium solids (metal and oxide) are in conformance with the DOE metal and oxide standard by May 2002.

Based on screening evaluations performed in support of the Interim Management of Nuclear Materials EIS, these materials will be identified as candidates for stabilization primarily due to the presence of plastic in the packaging. The EIS will contain an evaluation of options for stabilizing these materials. Consequently, the plans outlined below to meet the standard are contingent upon the ROD, due in July 1995.

Based on available material and packaging information, there are 12 containers of metal turnings where plutonium metal is known to be in direct contact with plastic. These materials will either be processed to a safe storable form or repackaged by December 1995. Assuming the ROD on the Interim Management of Nuclear Material EIS supports processing, the materials will be dissolved and processed to metal using the F-Canyon and the FB-Line facilities. If processing is not selected, the material will be repackaged to eliminate metal in direct contact with plastic.

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

It is anticipated that a new or modified Actinide Repackaging Facility will be required to fully meet the metal and oxide storage standard. This facility will not be available until at least 2001 (assuming the approval of an FY98 Line Item Project) and would incorporate bagless transfer and high temperature calcination technology to ensure that plutonium materials could be treated and repackaged to meet the metal and oxide storage standard. This facility would be coupled with a new or modified vault to permit consolidation of plutonium materials into a facility suitable for extended interim storage and facilitate international inspections.

To demonstrate the technology and to provide an interim capability to meet the metal and oxide storage standard where practical, Savannah River is planning to install a bagless transfer system in the FB-Line facility. SRS has already completed proof-of principle testing for the bagless transfer system in a non-contaminated environment. The modifications are scheduled for completion by the end of FY97. If the demonstration is successful, some of SRS materials, particularly plutonium metal items, could be repackaged to the metal and oxide storage standard in this facility. Implementation of this system will be evaluated for use at other sites.

Savannah River is exploring the feasibility of modifying equipment within the FB-Line for thermal stabilization of oxides. However, technical evaluations have not been completed.

Key challenges include the demonstration of the bagless transfer system, digital radiography, and thermal stabilization by modified equipment; completion of the new actinide packaging capability; and the continued extended use of the FB-Line facility.

3.2.4 Implementation Approach for Hanford Plutonium Metals and Oxides

This material category includes the current inventory of plutonium metals and oxides at the Plutonium Finishing Plant (PFP) of approximately 2,850 items. These items are stored within the PFP vaults. All plutonium metal and oxide is packaged to meet Hanford's existing packaging and storage criteria of less than 1 wt% loss on ignition. Plastic is not in direct contact with the plutonium. Therefore no immediate storage hazards exist and no urgent actions are required; although all metals and oxides require stabilization and/or repackaging to meet the metal and oxide storage standard.

In addition to the packaging criteria, PFP has an extensive monitoring and surveillance program that includes an engineered (automated temperature, pressure and safeguards) monitoring system. This program has proved successful at identifying suspect packages in sufficient time to allow for safe handling and repackaging of an item before container rupture. While PFP experiences 3 to 7 suspect containers that require repackaging each year, there has not been a vault-stored item rupture since the implementation of the packaging and storage criteria approximately 15 years ago.

The metal items currently stored at PFP can be repackaged without stabilization. Repackaging requires the development and installation of a new repackaging line to include a "Savannah River type" bagless transfer capability for containing the material. Engineering studies are scheduled for FY95-96 until funding can be secured in FY97 following issuance of the EIS. After completing detailed design, equipment procurement, and installation in 1998, the operations would commence in 1999 following staff training, procedure preparation, and operational readiness testing and reviews. Metal repackaging would be completed by the end of FY00.

Since the long-term storage goal for oxides requires stabilization to meet a loss on ignition of less than 0.5 wt%, the items at PFP require restabilization. Restabilizing this material is expected to start upon completion of stabilization of two other categories of material: solutions and residues/low-assay, mixed oxides. PFP will, therefore, start restabilizing these high assay oxides in 1999 with completion anticipated in early 2002. To stabilize the oxide, a series of muffle furnaces will be used; the same furnaces for stabilizing the sludges and the reactive solids. Higher capacity and shorter cycle times are expected for this class of material because of its stable nature and lack of organic constituents. The through-put for the oxides would be approximately 2,200 kg/yr using all 11 furnaces. After thermal stabilization, the oxide will be cooled in a controlled environment and then repackaged. Additional studies are planned to verify that the engineering design assumptions are consistent with exposure requirements for personnel.

3.2.5 Implementation Approach for Los Alamos Plutonium Metals and Oxides

Los Alamos National Laboratory (LANL) will design and qualify a suitable container for long-term storage of plutonium metals and oxides; conduct plutonium storage behavior studies and surveillance testing; and establish quality-assured operations for processing and packaging of plutonium metal and oxide for long-term storage. Los Alamos has established operations for plutonium metal and oxide stabilization and repackaging for the PF-4 vault that meet the DOE-STD-3013-94.

Approximately 2.6 metric tons of plutonium will be stabilized for long-term storage through separation of oxide from metal, calcination of the oxide, and processing of residues to oxide. Repackaging prioritization has been established. Surveillance of the vault inventory will identify high risk items that will be promptly stabilized and packaged for safe near-term or long-term storage.

The schedule for repackaging of the inventory calls for initially processing and repackaging plutonium metal and oxides to long-term storage standards by 1997, followed by completion of processing plutonium residues to stable oxide and repackaging by 2002.

The Los Alamos project will first repackage a group of items consisting of partially oxidized pure metal. A double encapsulation stainless steel containment system has been tested and is being qualified for long-term storage of plutonium metal and oxide. Testing data verify that the inner and outer containers are capable of maintaining their structural integrity and providing proper containment for the maximum theoretical pressure generated by radiolysis and chemical reaction in the stored material. Welding parameters are being refined. Container cleanliness criteria and a cleaning procedure have been developed. Inert gloveboxes to enable welding in helium atmospheres are in place and operable. Ambient helium surrounding special nuclear material provides leak-check capability, heat-transfer, and a nonreactive atmosphere in the container.

Los Alamos has established metal and oxide processing operations for long-term storage. Experimentation on the efforts of oxide calcination temperature on the basis of loss-on-ignition, particle size, and surface area is in process. The effects of relative humidity and time on water uptake of the calcined oxide are being studied. Research is continuing on nuclear material/container compatibility. Several surveillance diagnostic tools are being considered to determine pressure changes within the material container, such as resonance spectroscopy and aneroid bellows. An initial assessment of project quality assurance has been completed. After completion of a peer review in April 1995, packaging operations to the long-term storage standard will begin.

The TA-55 plutonium facility in Los Alamos has been in continuous operation since 1978. Residue and oxide processing, metal handling, and welding operations have been a normal part of continuing operations. Repackaging at TA-55 has been reviewed for compliance with the National Environmental Policy Act by Los Alamos. The repackaging operations are scheduled to be integrated and demonstrated in April 1995 with repackaging of plutonium metal and oxide to begin in May 1995. All metals and oxides are expected to be repackaged to the metal and oxide storage standard by May 2002. Included within this schedule is the possible stabilization and repackaging of excess metals and oxides from Lawrence Livermore.

3.2.6 Implementation Approach for Lawrence Livermore Plutonium Metals and Oxides

Lawrence Livermore National Laboratory (LLNL) has metal and oxide material in active programs in support of Defense Programs missions. The plutonium metal inventory includes about 250 containers that use the aluminum foil barrier system. The plutonium oxide inventory consists of 157 containers. These materials are located in Building 332, which is a fully functioning facility that meets federal, state, and local environmental regulations as outlined in the LLNL Environmental Impact Statement.

A project to identify, characterize, and non-destructively assay all plutonium items in inventory is identified in the Plutonium ES&H Corrective Action Plan. This plan is in-process and scheduled for completion by January 1997. Lawrence Livermore does not believe there is any metal packaged in direct contact with plastic; however, any items found during this inventory process will be immediately repackaged with aluminum foil barrier. Excess plutonium metal items are scheduled to be repackaged in compliance with DOE-STD-3014-94 by 2002. Initial inspection of metal items will begin in April 1995.

LLNL has the means to repackage excess plutonium metal and oxide in compliance with the standard, however, it is considering improved methods for repackaging metal, and transferring and calcining oxide. These improved methods could reduce operator radiation exposure and potential worker contamination during decontamination of the storage cans. Repackaging of the material to meet the metal and oxide storage standard will be begin by May 1996.

LLNL is also investigating a second option, namely, the possibility of shipping the excess plutonium to Los Alamos for processing, packaging or storage. This option is being discussed under the auspices of the Integrated Working Group (IWG). Successful shipment of the excess plutonium materials from the LLNL site may eliminate the need to process and package this material at LLNL. However, the combined cost to prepare the material to meet shipping requirements and the cost of reprocessing at LANL may be more then the cost of processing and packaging at LLNL.

3.2.7 Implementation Approach for Other DOE Site Plutonium Metals and Oxides

Many DOE sites that have small quantities of plutonium with a combined inventory less than 5 kg; most in the form of sealed sources. Metal, oxide, and solutions mak up the remainder. Under this implementation plan, all metals and oxides that are excess to programmatic need will be considered for consolidation at the larger sites that have, or will have, capabilities for processing and repackaging the materials to th metal and oxide storage standard.

3.2.8 Key Milestones

- Repackage all plutonium metals in direct contact with plastic:

  RFETS . . . . October 1
  SRS (repackaging of metal turnings) . . . . December 1
  Mound . . . . September 199

- Thermally stabilize all existing backlog reactive plutonium oxide:

  RFETS . . . . October 199

- Conduct a sampling and inspection program to determine the relative risk and priority for repackaging plutonium metals and oxides in close proximity with plastic and other synthetic materials:

  RFETS . . . . July 199

- Repackage plutonium metals and oxides in close proximity with plastic depending on risk:

  RFETS . . . . October 199
  Stabilize all newly generated plutonium oxide . . . . Ongoin

- Repackage all plutonium metals and oxides to the metal and oxide storage standard:

  All Sites . . . . May 2

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

Part I: Stabilization Requirements

3.3.1 General Overview

Background

The DOE currently manages a significant quantity of bulk materials contaminated with significant quantities of plutonium, defined as solid process residues. The residues represented feedstock and materials-in-process to nuclear weapon fabrication and nuclear material production until fabrication ceased in 1989. The residues are contaminated by materials such as impure oxides and metals, halide salts, combustibles, ash, dissolver heels, sludges, contaminated glass and metal, and other items. Since 1989 these residues have remained in packages in processing areas, vaults, and process lines awaiting disposition. They are not currently in a configuration suitable for long-term storage. Processing, treatment, stabilization, and/or repackaging are required to secure them in a safe, stable end-state. Table 3.3-1 indicates the quantities of solid residues at the various DOE facilities.

Table 3.3-1: Summary of Plutonium Residue and Mixed Oxides (<50% Assay)

Site	SNM Inventory (Kgs)	Number of Items	Location
Rocky Flats	3,000	20,532	371, 559, 776/ 777, 779, 707, 771, 991
Hanford	1,500	5,000	PFP, Purex, PNL
Los Alamos	1,400	6,300	TA-55, CMR
Savannah River	Classified	1,306	235-F, FB-Line, SRTC
Lawrence Livermore	35	182	B332
Mound	3	39	T Building
Argonne-East	<1	12	
New Brunswick	----	----	
Oak Ridge	0.1	12	3027, 7930
Sandia	----	----	
Lawrence Berkeley	<1	250	

Overview of Concern

Within the solid residue inventory, many forms are corrosive, chemically reactive and difficult to contain, particularly when they are exposed to air and moisture. Hazards are generated as a result of either poor package design or packaging failure stemming from radiolysis and pressure buildup which contribute to the problem. Like other forms of plutonium, residues in contact with plastics cause radiolysis, hydrogen generation, and pressurization, making these packages susceptible to leaks or ruptures. Many packaging failures have occurred already. These failures have involved highly corrosive salts, fluoride-based reduction slags, plutonium oxide, and incinerator ash among others. Clearly, not all materials and packaging weaknesses within the inventory have been identified or characterized adequately. In fact, the long-term storage properties of materials are not well known. Action is needed both to respond to emerging hazards as well as to improve understanding of the long-term stability of these packaging materials. This effort is focused on arriving at the most desirable pathway to the acceptable end-state; using efficiency, cost, ALARA, waste, and facilit constraints as elements of the acceptance criteria.

Applicable Sub-recommendations from DNFSB Recommendation 94-1

Sub-recommendation 1a:

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 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.

Sub-recommendation 2:

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

Sub-recommendation 5:

That preparations be expedited to process the containers of possibly unstable residues at the Rocky Flats Plant [Rocky Flats Environmental Technology Site] and to convert constituent plutonium to a form suitable for safe interim storage

Acceptance and Objectives

The DOE fully concurs with the DNFSB observations and recommendations on processing and stabilizing solid residues. Because of the complexity of the physical and chemical nature of the material forms and the storage configurations of the residues, the solid residue storage issue is similarly complex. The decision logic, as shown in Figure 3.3-1 for stabilizing the residues involved classifying them into one of three risk categories:

- High Risk: Condition likely to occur within 2-3 years and worker exposure consequence is unacceptable.

- Moderate Risk: Condition not likely to occur immediately but likely in 3-8 years and worker exposure consequence is above annual regulatory limit for routine operations.

- Low Risk: Condition not likely to occur in foreseeable future and worker exposure consequence is within operation limits.

By addressing the risks to workers, the risks to the public and environment are also mitigated. This assessment of risk is based on the results of the DOE Plutonium ES&H Vulnerability Assessment (DOE/EH-0415).

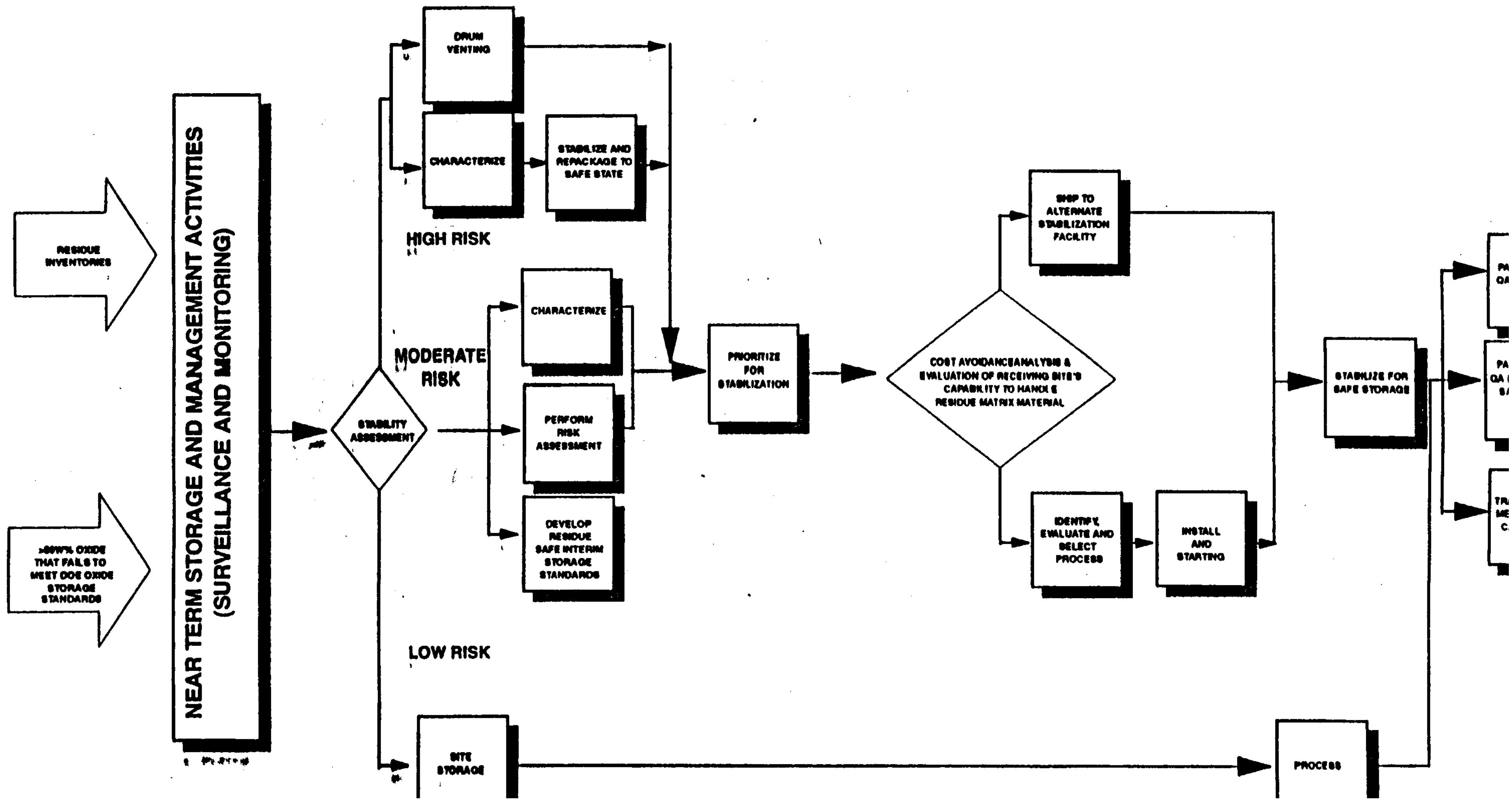
The Department has split the action response for the stabilization of the three risk categories into two separate, albeit integrated, paths: 1) the stabilization and repackaging of high-risk residues, which has already begun and will be completed within 3 years, and 2) the establishment of a managed (planned, scheduled, and resource-loaded) program, with appropriate NEPA analysis, whereby all remaining residues will be prioritized, processed, stabilized, and packaged for long-term storage or a form suitable for disposal within an 8-year time frame. Characterization will continue in parallel along both paths where any uncertainties exist as to the contents of containers or the packaging configurations in an effort to better determine the proper stabilization path. This will include an aggressive research and development plan focused on more accurately understanding materials and packaging weaknesses, filling in gaps in technology and information needed in process selection and modification, as well as to gain a better understanding of long-term material and packaging stability.

In proceeding down the two paths, the general basis for achieving the objective of having a safe and stable inventory is as follows:

- Minimize the multiple handling of material in an effort to both reduce personnel radiation exposure and improve cost efficiency.

- Work across the DOE complex will be performed to a common set of residue category definitions and use a common risk-based approach to prioritization.

PU RESIDUES AND MIXED OXIDES FLOW CHART



- Separate the hazards from the residue matrices, where appropriate from a cost benefit basis, so that the hazardous materials can be packaged according to the new DOE Metal and Oxide Packaging Standard, and the bulk residue can be discharged directly without further waste management cost.

- Avoid the use of RCRA listed hazardous materials and characteristics to preclude the generation of mixed waste.

- Adopt pollution prevention concepts such as reagent recycle systems where they are cost-effective.

- Define and use a DOE-approved set of safe interim storage standards for solid residues to use as an acceptable interim state until ultimate disposal can be achieved.

- Through risk/cost benefit analysis, identify and strive to use processes and produce end-states that minimize the life-cycle cost of long-term nuclear material management to include ultimate disposal.

- Minimize or eliminate waste generation from any processing path, meet all state and federal disposal regulations, avoid the introduction of additional reagents, and use existing residues as reagents.

Part II: Plutonium Residues and Mixed Oxides Integration Activities

Approach

Functions Required to Accomplish Objectives: The key functions required to be in place for the implementation of the complex-wide approach to addressing the solid residue issues are as follows:

- Compensatory surveillance and monitoring activities that ensure that safe storage conditions be achieved until processing to the appropriate safe storage state occurs.

- Operational stabilization technologies that strive to achieve the above set of principles for all residues categorized as high risks to process (see Path 1 below).

- Common characterization approach to selection and prioritization of items for processing or stabilization (see Path 2 below).

- Safe interim storage capabilities and capacity.

- For all residues other than the high-risk category, processing technologies ar capacity to convert those materials to meet the DOE standards for metals ana oxides, criteria for available repositories, or a new standard to be developed fo safe storage of specific residues.

- Packaging and shipment capabilities and facilities.

Path 1- High Risk Material Handling: This path strives to meet the 3-year target for mitigating risk associated with all high-risk residues. The materials in question exist in numerous facilities around the country. They have been generated via a number of different processing approaches. The sites individually have the knowledge of current material status and are best prepared to respond to the high-risk materials category rapidly. Each site has implemented a risk-based approach for evaluating the inventory and for identifying those items deemed high risks for stabilization. The residues will be dealt with in one of four ways:

- By processing to a form that complies with either an established or new standards for long-term storage or disposal. This is the preferred approach.

- By processing to a form that will be stable for an interim period (such as a fev years).

- By repacking the residue to eliminate, at least for an interim period, the caus of the instability. (Ventilation is likely to be the most profitable type of repackaging).

- By ascertaining through investigation and characterization that the residue is nc possibly unstable.

For each site, the materials falling into the high-risk category include:

- RFETS: Certain pyrochemical salt reagents, sand slag, and crucible (SS&C), certain sludges, graphite fines, and certain combustibles.

- LANL: Single containment pressure vessels, solutions, selected pyrochemical salts, sand slag and crucible, gases, selected combustibles, certain Pu metal items, and certain sealed sources.

- SRS: SS&C and reduction residues.

- Hanford: Sludges, certain incinerator ash, solutions, reactive solids such as SS&C, and combustibles.

- LLNL: Ash.

- Other (Sites with small holdings): None.

The individual site reports found later in this section provide a detailed discussion of the specific materials, processing approaches, and schedules.

Path 2-Managed Material Handling: This path deals with all other remaining residue inventories. The target is to stabilize and package all of the remaining materials within 8 years in such a way that they 1) will meet the new DOE-approved safe interim storage standard for residues "as is"; 2) will be processed to partition the actinides from the residue matrix so that the actinides can be stabilized to meet the DOE standard criteria for safe storage of plutonium metals and oxides (DOE-STD-3013-94); or 3) will be packaged to meet the criteria for waste repositories (see Figure 3.3-1). In the latter case, the resulting matrix waste will be sent to the appropriate storage repository. The necessary efforts associated with this path will be initiated immediately and will proceed in parallel with Path 1.

The Department will, in conjunction with appropriate NEPA analysis, establish a formal, integrated management system for determining the order in which the material categories will be prioritized, processed, stabilized, and packaged for long-term storage. The first step is to arrange the materials into commonly defined groupings. Material holdings at each site are classified into at least one of nine major groupings as outlined below. These broad groupings are further subdivided at each site, as appropriate, according to the way the materials are to be processed.

- Mixed Oxides <50% assay
- Alloys <50% assay
- Chloride-based salts
- Combustible materials (e.g., paper, rags, plastic, gloves)
- Ash, ash heel, and particulate residues
- Fluoride-based residues
- Sludges and wet residues
- Miscellaneous inorganic materials (e.g., glass, metal, ceramics)
- Other

Clearly Defined End-States: Acceptable end-states include material treated and packaged to a safe interim storage state for a residue grouping, material stored in compliance with the DOE Metal and Oxide Storage Standard, or material treated and packaged in compliance with criteria for acceptance by the waste repository to which the material is to be sent.

Characterization: All residues will be characterized by process knowledge, Non-Destructive Assay (NDA), Non-Destructive Evaluation (NDE), selected monitoring of the material physical properties, or analytical chemistry methods to ensure that the properties of the residue materials are adequately known to understand safety implications. These data will be documented formally and become a part of each residue package's historical data base.

Risk Assignment: All residue material groups will be evaluated using a formalized risk-based approach (see Key Challenges section, below) based on their characterized properties and their packaging configurations. Each site will document the current risk-based assessment of their residue holdings that results in assignment of residue into one of the three defined stability categories outlined earlier.

The methodology will be to assign a risk category to each material group, based on consideration of the following factors:

- Known information about materials and packaging, which will be evaluated fc the presence of potential hazards. Known hazards include, for example, the presence of flammable gas, shock-sensitive materials, ignitable or flammable materials, pressure build-ups, corrosives, incompatible chemicals or reactive metals, and significant container degradation.

- The likelihood of failure resulting in adverse radiological safety and health consequences.

- The severity of consequences to the worker, the public, and the environment, a failure occurs.

In effect, this is a dynamic, risk-managed process because materials will constantly b moving into the residue management system and among categories within the syste Evaluation and prioritization must be continuous.

Option Analysis: Selection of the end-state and stabilization pathway will be documented by trade studies and NEPA analyses as appropriate.

- The functions required to accomplish each pathway will be defined along witl all identified key issues and barriers.

- A standard set of decision criteria will be defined and used for comparison of alternatives. Criteria will be included for minimizing life-cycle cost, improving schedule, reducing technical risk, reducing environmental safety and health risk, minimizing waste generation, maximizing facility utilization, considering of other programmatic and site-specific objectives.

- Technical peer reviews will be conducted as appropriate to validate conclusion

- Cross-cutting studies will be utilized to the extent practical to establish comm factors and approaches.

- Inter-site shipment options will be explored where appropriate.

Plans: An overview of the base-case disposition approach currently planned at each site is outlined in the following site-specific sections. More detailed documentation of the baseline facility-use strategy and schedule will be developed as part of each site's Management Plan.

Key Challenges

Several challenges must be met to fulfill DOE's objectives for stabilization of residue. DOE needs:

- Establishment of a uniform approach to risk classification of plutonium inventories in order to prioritize stabilization activities.
- Development of a common approach to selecting the pathway for overall nuclear material management for items that are less than 50% assay.
- Development of a set of safe interim storage standards for materials that are less than 50% assay.
- RCRA requirements for storage, treatment, and disposal may have a significant impact on stabilization and packaging plans.
- Establishment of shipping and receiving agreements and residue shipping containers.
- Development and implementation of a strategy for stabilizing and packaging residues at smaller sites for safe interim storage that optimizes use of complex-wide capabilities.
- Obtaining disposal capacity for the resulting waste.

Part III: Individual Site Activities

3.3.2 Rocky Flats Plutonium Residues

Rocky Flats has 100 metric tons of residues with low concentrations of plutonium stored in seven facilities. About 3 metric tons of plutonium are contained in 3,928 drums and 3,909 cans (for a total of over 20,000 packages) located in vaults and process areas. The plutonium in these drums and cans accounts for a large fraction of the 12.9 metric tons of plutonium and the vast majority of the over 27,000 packages of plutonium at the site. The classes of material, quantities, concerns, and 3- and 8-year actions are summarized in Table 3.3-2 below. Preliminary identification of the processes have been made for planning purposes. The material classes have been identified according to the logical stabilization process required to eliminate the concerns. Additionally, all residues were initially categorized into risk categories (through 5) to prioritize them for treatment. (Note: This was a unique risk categorization approach developed at RFETS in prioritizing the initial residue set.) Figure 3.3-2 provides a risk categorization for the Rocky Flats residues by Item Description Code (IDC).

Salts are of concern because they contain reactive metals, especially plutonium metal shot. They are also corrosive and can generate hydrogen gas from contact with plastic; and any absorbed water in the matrix. Pyrochemical oxidation will destroy tl reactive metals and drive off water.

Combustibles consist of paper, plastics, rags, gloves, ion exchange resins, filters, and oil- and grease-contaminated residues. All combustibles generate hydrogen from the radiolysis of the matrix. However, the risk resulting from the pressure build-up has been mitigated at Rocky Flats in the short term by venting the drums. Ion exchange resins in nitrate form constitute a fuel and oxidizer in intimate contact. RFETS and LANL are exploring cementation of the resins to mitigate this safety issue. Some of the combustibles contain cellulosic materials, which are of concern due to the presenc of nitric acid and nitrates or oil. The best long-term technical approach to address all of the above combustible safety issues is to destroy the matrix that involves incineration. However, permitting an incinerator can be a difficult and lengthy proces Consequently, RFETS is pursuing a parallel path approach, which includes the pilot fluidized bed incinerator (FBI) in Building 776 while at the same time exploring alternatives to incineration for short- and long-term mitigation of safety issues. Alternative technologies will be evaluated based on their merit and will include an evaluation of technical and programmatic risks, safety, permitting, waste generation, throughput, and technology maturity.

Ash generates gas from radiolysis of residual organic material. SS&C and graphite contain reactive metals. Calcination of these materials is the process for removing these hazards. *Wet/miscellaneous* materials generate hydrogen from plastic packaging residual water, and organic materials. A variety of methods will be used to eliminate these hazards. *Inorganic* materials, such as LECO crucibles, light metal, and glass, only require venting of current packaging and/or repackaging to eliminate plastic in contact with plutonium.

RFETS has the following objectives:

- High risk residue groups will be mitigated/processed into a stable form within three years.
- The remaining residue groups will be processed into a stable form within eight years.

Table 3.3-2: Rocky Flats Residues

Class	Description	Quantity	Concern	3 Year Action	8 Year Action
Salts	Pyro salt reagents	15,980 kg in 641 drums and 2,954 cans	Reactive metals, Plastic packaging	Treat category 1&2 and salts in occupied areas	Treat remaining salts
Combustibles	Paper, plastic, grease, resin	17,495 kg in 748 drums and 4 cans	Hydrogenous matrix; nitrification; spontaneous combustion		Treat combustibles
Ash	Incinerator ash; sand, slag & crucible; graphite	27,433 kg in 1,426 drums and 456 cans	Reactivity of metals; Hydrogenous matrix	Treat SS&C, and graphite fines; vent others	Treat remaining ash
Wet/Misc	Acid-contaminated sludges, classified shapes	12,640 kg in 448 drums and 366 cans	Plastic packaging causing hydrogen generation	Vent all containers	Treat all materials
Inorganics	LECOs, light metal, glass, Raschig rings	32,794 kg in 665 drums and 129 cans	Plastic packaging causing hydrogen generation	Vent categories 1&2	Repackage all materials

Specific actions to be taken with respect to the residue groups are as follows:

- *Salts:* Category 1 and 2 risk groups and other residue groups in this class stored in occupied areas (i.e. outside of vaults) will be processed and repackaged for safe storage and/or off-site shipment within three and one-half years. Stabilization will be accomplished by pyrochemical oxidation using existing and newly installed furnaces in Building 779. Approximately 6,000 kg of salt can be processed by May 1997, with the remaining high hazard salts completed by December 1997.

- *Combustibles:* All high-risk combustibles will be processed and repackaged within four and a half years with the balance to be completed within eight years. As a compensatory measure, RFETS has mitigated many of the safety issues associated with combustibles through venting and surveillance. The potential for off-normal occurrences associated with fire scenarios involving combustibles is adequately mitigated until the planned combustible processing capability start-up. The installed fire detection and fire suppression systems minimize the probability of occurrence of large fires. The Conduct of Operations program provides training and qualification of operators in fire

ROCKY FLATS RESIDUES
ITEM DESCRIPTION CODES (IDC) RISK BREAKOUT

	HIGH RISK	MODERATE RISK	LOW RISK
SALTS	363, 364, 404, 405, 407, 408, 409, 410, 411, 412, 413, 414, 415, 427, 429, 443, 473, 654, 655	333, 365, 405, 406, 407, 409, 410, 411, 413, 414, 415, 418, 427, 429, 433, 434. 473, 654, 655	044, 416, 426
COMBUSTIBLES	NONE	330, 337	NONE
ASH	312, 368, 372, 378, 390, 391, 392, 393, 394, 398, 420, 421, 422, 423	089, 368, 378, 390, 391, 392, 393, 394, 395, 396, 398, 419, 420, 421, 428, 601	310, 374, 387
WET/MISC.	290, 291, 292, 299, 331,332, 335, 336, 339, 340, 341, 342, 373, 430, 431, 441, 485, 490	H61, 099, 290, 292, 299, 340, 441	090,0901, 092, 093, 097, 301, 338, 376, 486, 489
INORGANIC	320, 360, 371, 377, 440, 442	312, 334, 371, 377, 438, 440, 442	197, 300, 303, 320, 321, 370, 479, 480
OTHER	050	NONE	080

safety, which minimizes the human error occurrence rate. The Rocky Flats Fire Department fire and combustible loading ensure continued system operability and risk minimization. Combustible drums are inspected daily as well as every shift during rounds by Stationary Operating Engineers, Shift Managers, and Radiological Operations personnel. RFETS will continue to pursue short- and long-term mitigation and stabilization alternatives such as cementation of resins, washing and drying combustibles, pyrolysis, and non-thermal destruction technologies.

- *Ash:* All residue groups represented by SS&C IDCs, as well as all of IDC 310 (graphite fines), will be processed and repackaged in three years. All other IDCs will be vented in three years and processed and repacked within eight years. Stabilization will be accomplished using existing casting furnaces in building 707. All high hazard materials can be completed by May 1997.

- *Inorganics:* These residues will be vented within 3-years and will be repackaged for off-site shipment within 8-years. Repackaging operations will continue in building 707.

- *Wet/Miscellaneous:* These residues will be vented within 3-years and will be processed and repackaged within 8-years.

The above "venting" commitments will be accomplished under the purview of the drum venting effort, which has committed to venting 2,045 drums in FY95, and the remaining unvented residue drums by the end of FY96. An analysis will be performed to determine if venting a drum in advance of its processing is warranted, or whether near-term (3-year) processing precludes the need to vent certain drums.

It should be pointed out that what is being proposed by RFETS for residues is very aggressive. There are a number of critical assumptions, which could impact the schedule. These include: sufficient non-destructive assay capability is available; sufficient material movement/staging capability is available; sufficient waste storage space is available; RCRA permits are granted in a timely manner (apx. 18 mo.); NEPA analysis completed in a timely manner; sufficient and timely funding ; sufficient and necessary personnel are available, not withstanding contract transition and layoffs.

3.3.3 Savannah River Plutonium Residues

The SRS has residues in four categories: 1) 212 containers of Metal and alloy residues <50% assay; 2) 614 containers of oxide residues <50% assay; 3) 413 containers of potentially reactive materials such as SS&C, sweepings, turnings, alloys, and oxides; and 4) 67 containers of miscellaneous residues. These materials are stored in the F-Area vaults, and are considered to be possibly unstable and thus unsuitable for long-term storage. The degree of concern varies depending on the isotopic content, chemical impurities, and packaging. A breakdown of these materials is shown in Table 3.3-3.

These materials were classified as at-risk, or possibly unstable as a result of the ES Pu Vulnerability Assessment. They also have been identified as candidates for stabilization in the Interim Management of Nuclear Materials EIS. The ROD for the EIS is planned for July 1995 and is considering the following options:

- Mitigation of immediate vulnerabilities by repackaging in existing F-Area facilities, and continued storage of other plutonium scrap in existing packages.
- Continuation of active monitoring and management of the packages until the new Actinide Repackaging Facility is built and operational.
- Processing to oxide, dissolving material in F- or H-Canyon, purifying the plutonium, and transferring the solution to FB- or HB-Line for conversion to a metal or oxide.
- Vitrification of selected materials using the proposed MPPF or DWPF vitrification processes.

Depending on the decision in the ROD, the assumed stabilization pathway for these materials is to repackage the items that are greater than 100 grams to meet the residue safe interim storage standard (to be developed) and to stabilize the other materials via aqueous processing. Until the stabilization options can be exercised, the materials are under a surveillance and monitoring program that includes visual inspection and statistical sampling. The design features of the vault minimize worker risk in a packaging failure.

Table 3.3-3: Savannah River Residues

Class	Description	Quantity	Concern	3 Year Action	8 Year Action
Metal and alloy residues <50% assay	Mixed metals and alloys (contain EU, etc.)	39 items greater than 100 g/can. 173 items less than 100 g/can.	Plastic in proximity, high surface area, possible reactives, un-characterized	Characterize and begin processing items that can- not meet new or planned standards	Stabilize and pac new storage crite residue criteria to developed
Oxide residues <50% assay	Mixed oxides and compounds	251 items greater than 100 g/can. 363 items less than 100 g/can.	Plastic in proximity, uncharacterized	Characterize and begin processing items that can- not meet new or planned standards	Stabilize and pac new storage crite residue criteria to developed
Reactive solids	Sand, Slag, Crucible, and reduction residues	413 items now. Over 130 more will be generated during cleanout.	May pressurize or corrode over time	Process	Package resultant plutonium to mee criteria
Other	Misc. items in other residue categories	67 items less than 100 g/can	Poorly characterized	Characterize and begin processing items that can- not meet new or planned standards	Stabilize and pac new storage crite residue criteri developed

Note: Table excludes samples and standards, and shown actions are contingent upon EIS outcome.

Where material and packaging properties are characterized incompletely, a program will be instituted to select the required stabilization process. Methods used will include NDA using digital radiography equipment, to be installed by late 1997 and selected sampling of containers using existing gloveboxes with modification.

Current plans call for the repackaging of all existing high-grade, mixed plutonium solids (>100 g/can) to meet the new residue safe interim storage standard. This would require the new Actinide Repacking Facility (ARF) to be available in 2001, provided it is approved as an FY98 line item. This new facility would be coupled with a new vault to permit consolidation of plutonium materials into a single facility. A new technology bagless transfer system will be demonstrated in the existing F-Area facility by September 1997.

The other possibly unstable residues are slated for processing in the canyons: the more reactive material, such as SS&C, in FB-Line or F-Canyon; and the mixed, low-grade solids in the HB-Line. The material processed in FB-Line will be transformed to metal for storage, while the material processed in HB-Line will be transformed to oxide. Depending on the decision in the ROD, processing in the F-Area will begin in FY96. Processing existing inventories of SS&C materials will be completed by December 1997. Other chemical processing activities will be completed to have all materials meet the storage standard by May 2002.

Key assumptions in achieving the above include 1) IMNM ROD in July 1995 to support the plan; 2) the development and installation of the bagless transfer system; 3) new packaging facilities to meet standards; and 4) the completion of modifications to the existing facilities to support container opening and repackaging.

3.3.4 Hanford Plutonium Residues

Hanford has several classes of materials at its Plutonium Finishing Plant (PFP), ranging from stabilized mixed oxides to unstable sludges stored in process gloveboxes. The PFP accounts for the majority of Hanford plutonium inventory, roughly 5,000 items with about 1.5 MT of plutonium. The classes of material, concern, and near-term and long-term actions are summarized in Table 3.3-4. Processes for stabilization and cleanout of the PFP are being evaluated in ongoing PFP-related National Environmental Policy Act (NEPA) documentation. When NEPA documentation is complete, the selected stabilization processes will be installed and operated to place all of the material in a form suitable for vault storage. The highest priority will be to deal with unstable materials first. For example, the existing inventory of glovebox-stored reactive sludge is unstable and does not meet the current Hanford criteria for vault storage.

One special class of <50% Pu oxides is unirradiated encapsulated Fast Flux Test Facility (FFTF) fuel pins, which are presently stored both at PFP and at FFTF. All individual pins and fuel assemblies (217 pin configurations) are considered to be safe for long-term storage and that fuel is not being considered for further stabilization or repackaging. It is expected that all of the fuel rods an assemblies will eventually be stored at PFP until final disposition is determined.

Table 3.3-4: Hanford Plutonium Residues

Class	Description	Quantity	Concern	3-Year Action	8-Year Plan
Interim stable solids <50 wt% assay	Lower grade oxides, mixed oxides, alloys	2.850 items	Material meets current Hanford criteria for storage; does not meet DOE Standard	None. Material has been stabilized and packaged to current Hanford criteria.	After reactive material and sludges are treated; stabilize and package material to new Hanford criteria for interim storage
Miscellaneous solid residues	Ash, slag and crucible	1,625 items, 1.890 kg bulk	Material does not meet current Hanford criteria for storage; may pressurize over time	The 46 items of ash will be stabilized and repackaged.	Add additional furnace capability to thermally stabilize and package material for storage in accordance with new Hanford criteria for interim storage
Sludges	Wet, sludges, future cleanout residues	285 items Cleanout residues TBD	Wet, corrosive material is stored in process gloveboxes	Currently, sludges are being processed in two muffle furnaces to thermal-stabilize and package material to Hanford criteria for vault storage.	Maintain thermal stabilization capability to process future cleanout material, as needed
Combustibles	Polycubes, plastic, rags	280 items 245 kg bulk	Degrading matrix; material does not meet Hanford storage criteria and is stored in vented cans.	None. Material is stored in vented cans, subject to surveillance.	Develop pyrolysis furnace to process polycubes into oxides suitable for long-term storage

To ensure safe storage until the material can be processed, the PFP has an extensive monitoring and surveillance program. This program has proven successful in identifying suspect packages in sufficient time to allow safe handling and repackaging before a container rupture occurs.

A small amount of the miscellaneous solid residue category (46 items of Rocky Flats ash) has been identified in the plutonium vulnerability assessment and poses a risk due to the presence of unburned material that may pressurize during storage (See Table 3.3-5.). This material will be processed in the existing muffle furnaces after completion of sludge stabilization processing, scheduled to be completed by September 1995. Ash processing is scheduled to be complete by March 1996. Items not suitable for stabilization via the muffle furnaces, such as high-organic sludges, will be evaluated on a case-by-case basis for pretreatment and/or discard.

The remainder of the inventory is considered safe for continued storage until after the current PFP NEPA activity. Interim stable material has been processed to meet the current Hanford criteria for vault storage (<1.0 wt% loss on ignition) and is safe for continued storage. The slag and crucible containing reactive metals are packaged in accordance with current Hanford criteria and have not exhibited any problems during storage. The polycubes are packaged in a vented configuration in accordance with current Hanford criteria.

The residue materials in this group are not addressed by the current DOE standard for long-term storage of plutonium.

Processing of the remainder of the inventory to meet the long-term goal will depend on the ongoing PFP NEPA activities. Currently, additional muffle furnaces are anticipated to process the reactive solids and a pyrolysis furnace is planned to process combustibles. After the reactive material is processed, the interim stable material will be processed. Completion of stabilization of the reactive solids is projected to occur in January 2000. Subsequent stabilization and repackaging of the interim stable materials is projected for January 2002.

A polycube processing study will be performed to develop process design information after which a definitive design will be initiated. Stabilization is expected to start July 1999 and be completed in January 2001.

The following key assumptions apply to the development of the residues schedule:

- New process equipment (e.g., muffle furnaces, pyrolysis furnace, associated support equipment) will not require line item funding or extended funding approval (i.e., required funding will be provided on an expedited basis.)

- Operator dose rates associated with processing of this material will be acceptable without the need for extensive shielding or remote handling equipment.

- The muffle furnace process will be adequate for stabilization.
- The pyrolysis furnace process will be acceptable; modifications to the off-gas treatment process may require development.
- The ongoing PFP NEPA activities will produce a position that supports selection of the processes planned for stabilization.

3.3.5 Los Alamos Plutonium Residues

The material that is considered within the scope of the DNFSB Recommendation 94-1 is shown in Table 3.3-5 below.

Table 3.3-5: Plutonium Inventory*

Matrix	SNM (kg)	Net (kg)	Number of Items
Compounds	234	349	443
Gases	0.2	-	2
Combustibles	2	73	91
Glass	1	16	37
Graphite	4	134	94
MgO Crucibles	39	565	269
Non-Pu Metal	17	839	200
Non-Combustibles	1	134	55
Ash	26	159	142
Heels	73	352	224
Hydroxides	22	523	291
Sweepings	26	310	192
Misc. residues	27	335	139
Chloride salts	307	6140	927
SS.&C	27	675	200
Other	-	-	579

*Np and Am are additions to this inventory.

The overall priorities for stabilization are shown below:

- Items that present unusual radiation or release hazards:
  - Pu/Be neutron sources
  - PuF_6 gas
  - Any item visually confirmed during a vault inspection to have a potentially failed container as indicated by discoloration, cracks or holes, improper tape seal, container swelling or other nonstandard condition
  - Containers in the yard (single containment vessels)

- Items that are corrosive and can breach their current containers:
  - SSC (Iodine corrosion of the tin can)
  - Moist hydroxide cakes from chloride processing (chloride corrosion)
  - Moist pyrochemical salts (chloride corrosion)

- Items that are combustible or can easily form combustible mixtures:
  - Nitrated rags
  - Pu-238 rags

- Reactive/unstable mixtures such as organics in contact with radioactive material, calcium metal or solutions in interim containers:
  - Analytical solutions
  - Pyrochemical salts

Once prioritized, the items are being processed according to the approach shown in Table 3.3-6.

Table 3.3-6: Baseline Processing Approach by Residue Category*

Residue Category	Remediation Approach
Solutions	Pu/U precipitation with hydroxide or oxalate. Cake to calcination and sealed in long-term storage can when available. filtrate to TA-50 Low Level Waste Treatment.
Containers in the Yard	Clean out material, discard low Pu items, cement powder and vermiculite, leach remainder. Weld clean container and store at TA-54 Area G.
Pyrochemical Salts/Reactive Metals	Oxidize reactive metal (Pu/Ca) with carbonate and repackage in slip top cans. Initially dissolve and recover Pu with precipitation. Eventually, use salt distillation when appropriate.
Sand, Slag, and Crucible	Crush and pulverize to remove reactive metal. Dissolve to remove plutonium with Ion Exchange. Iodine captured in caustic scrubber and sent to TA-50 as caustic waste. Plutonium to long-term storage, effluent to evaporation/cementation.
Oxides/Heels/Sweepings/Hydroxide Cakes/Compounds.	<50wt% to dissolution and Pu precipitation. >50wt% to calcination (950C) and packaging for long-term storage.
Resins and Graphite	Immobilize in cement.
Gases	Scrub/Calcination for PuF6. UF_6 gases sampled and shipped to Portsmith for recycle.
Non-Combustibles/Glass/Non-Pu Metal	Discard low Pu items as TRU waste. Leaching for high Pu items and package as TRU. Leaded gloves are wiped and packaged as TRU. Particulates put into cement.
Ash	Calcination at 600°C to remove excess carbon. Leach to remove Pu by Ion Exchange. Heels to cement.
Sealed Sources	Dissolution in HCl, Pu removal by Ion Exchange.

* Mainly for Pu items, although generally true for U.

To eliminate reactive and corrosive hazards, several existing technologies have been identified and will be implemented. To reduce the life-cycle cost of radioactive material management and the long-term liability of handling and storing energetic materials, the final form must be as stable as possible. The only proven method to achieve this stability is to separate the plutonium or other radioactive material from the bulk material, discard the bulk as a proper waste form, and store the radioactive material as an oxide.

The items known to be unstable are those that have failed or potentially failed containers. Residue containers in the vault are visually examined, according to a procedure, every time an item is removed from or replaced in the vault. Vault operators have been trained to look for certain abnormal conditions on the containers such as discoloration, inadequate tape seals, bulging containers, and other visual indicators. If such a condition is found, photographic and written evaluations are started and the item is removed for further examination. If a problem is discovered, a team of trained individuals determines its severity, and either repacks or processes the item into a stable form. For example, if such an item is metal, it will be oxidized and then re-canned. Current plans are to visually inspect 100% of vault items by May 1995.

Site-specific issues include:

- Obtaining RCRA and NESHAPS permits.
- Meeting the NPDES limits for activity and nitrate at the TA-50 liquid waste disposal out-fall.
- Obtaining adequate funding to meet the 8-year schedule.
- Meeting ALARA requirements given an eight year schedule.
- Maintaining support facilities such as CMR and TA-50.
- Installing adequate uranium stabilization facilities and capability.

3.3.6 Lawrence Livermore Plutonium Residues

Lawrence Livermore National Laboratory has residue material (<50 wt.%) supporting DOE missions and residue material that is excess to the DOE missions. The plutonium residue inventory includes about 130 containers. In 1994, 111 of the ash/residue containers were considered unstable, because 8 containers were found to be pressurized. LLNL has in process a remediation project for these cans of ash/residue.

A three phase plan has been formulated for residue materials.

- The first phase of this remediation project stabilized the pressure within the original cans, by venting and has been completed.
- In phase, LLNL is conducting a trade-off study to develop plans for the stabilization and packaging of ash/residues for long-term storage. The initial step is characterization of the materials. The next step is to determine a stabilization process that will allow this material to be packaged for long-term storage. Stabilization, processing, processes being considered are, thermal processing, washing for removal of halides, vitrification, and conversion to a greater than 50% oxide. LLNL expects phase two to take one year. The "trade-off study" will be completed by April 1996.
- Phase three is the implementation of the stabilization and packaging methods developed in phase two. Stabilization and packaging will be complete by April 1998. Materials identified in the Pu ES&H Vulnerability study requiring

stabilization will be processed during the first year of the phase three operations. LLNL has the means to repackage these materials in compliance with the standard. Current capabilities could be improved to reduce operator radiation exposure and potential worker contamination during decontamination of the storage cans. LLNL will consider development of an advanced system for transferring and calcinating oxide.

LLNL is also investigating the secondary option of shipping excess plutonium to Los Alamos for processing, packaging or storage according to the metal and oxide storage standard. This option is being discussed under the auspices of the Integrated Working Group (IWG). Successful shipment of the excess plutonium metal from the LLNL sit may preclude the need to process and package this material at LLNL. However, the cost to process to meet shipping requirements and then reprocess at LANL may be more than if processing and packaging were performed at LLNL.

3.3.7 Other Plutonium Residues

A large number of DOE sites have small quantities of plutonium with a low potential for environment, safety, and health vulnerabilities. Most is in the form of sealed packages. Metals, oxides, and solutions make up the remainder. The DOE complex maintains a variety of packaged standards, encapsulated sources, and process-support or archival samples. The DOE also retains responsibility for many standards and sources that are loaned or leased to universities, hospitals, and industry. These items not constitute a major liability, as most are small, stable, sealed, and shippable. However, in aggregate, the future management of these technical materials is constrained by the few facilities that can receive the items and process them for disposal or reuse. DOE's Implementation Plan will ensure that small-quantity and unique items located at hundreds of sites do not interfere with those site's programs to reduce inventories of unneeded nuclear materials and comply with local radiological controls. One example of this integration is the recent consolidation of receipt and recovery activities for plutonium-beryllium sources to the Los Alamos National Laboratory.

Within the last two years, sources from more than 240 DOE, university, and industrial sites have been returned, or scheduled to be returned, for treatment or safe disposal.

3.3-8 Key Milestones

Table 3.3-8: Key Milestones and Commitments

	Commitment	Action	Date
1	Develop risk-based, complex-wide categorization and prioritization decision criteria that all stored residues will be required to meet	LANL(lead), RFETS, SRS,Hanford LLNL	Sept 95
2	Vent 2,045 drums with a potential for hydrogen gas generation	RFETS	Oct 95
3	Stabilize by pyrochemical oxidation, and repackage 6,000 kg of higher risk plutonium containing salts	RFETS	May 97
4	Stabilize remaining higher risk salts (4,000 kg) via chemical oxidation	RFETS	Dec 97
5	Stabilize all sand, slag, and crucible and graphite fines	RFETS	May 97
6	Vent all inorganic residues	RFETS	Oct 96
7	Vent all wet/miscellaneous residues	RFETS	Oct 96
8	Stabilize higher risk combustibles (11,000 kg)	RFETS	Nov 98
9	Develop complex-wide secondary material storage standard for materials that are less than 50% assay	DP EM	Dec 95
10	Identify, characterize, and non-destructively assay all Pu items	LLNL	Jan 97
11	Ship all excess items to LANL	LLNL	May 02
12	Pressure-stabilize cans containing ash/residue materials	LLNL	Complete
13	Conduct trade studies for ash/residue materials	LLNL	April 96
14	Stabilize, process, and package all ash/residue materials	LLNL	April 98
15	Stabilize sludge in muffle furnaces	Hanford	Sept 95
16	Stabilize 46 cans of selected ash in muffle furnaces	Hanford	Mar 96
17	Stabilize and package all remaining residues to safe interim storage standards	Hanford	May 02
18	Stabilize Polycubes	Hanford	Jan 01
19	Perform 100% visual inspection of vault inventory	LANL	May 95

	Commitment	Action	Date
20	Recover 100 neutron sources	LANL	Oct 95
21	Process 90% of analytical solutions	LANL	Oct 95
22	Process 100 kg sand, slag and crucible	LANL	Oct 95
23	Process 70 kg hydroxide solids	LANL	Oct 95
24	Oxidize 50 kg of corroded metal items	LANL	Oct 95
25	Stabilize existing inventories of SS&C	SRS	Dec 97
26	Stabilize remaining residues	SRS	May 02

3.4 Special Isotopes

Part I : Stabilization Requirements

3.4.1 General Overview

Background

The DOE manages inventories of a wide range of special transuranic isotopes, primarily derived as byproducts from previous defense reactor production and the chemical separation of large process streams of reactor targets. Many of the special radioisotopes have been widely used for medical, industrial, space exploration and other domestic and defense applications.

The primary "product" materials include Pu-238, used in compact power sources for NASA and terrestrial applications; Pu-242, an isotope that is valuable for defense research; and Cf-252, used as a medical isotope and in a variety of specialized cases such as non-destructive assay equipment. Feedstocks for the future production of heavy isotopes include neptunium, americium, and curium. In small amounts, many heavy isotopes are also useful as "tracer" elements in defense and non-defense research. Holdings that are relevant to Recommendation 94-1 are listed in Table 3.4-1

Table 3.4-1: Special Isotopes Holdings

Inventory	Location	Quantity
Americium-curium solution	Savannah River F-Canyon	14,400 liters
Pu-242 solution	Savannah River H-Canyon	13,300 liters
Np-237 solution	Savannah River H-Canyon	6,000 liters
Pu-238 solids with adverse packaging	Savannah River Building 235-F	14 containers
Pu-238 materials in active programs	Los Alamos, Mound, Savannah River	A wide variety of container types
Wide inventory of in-use and small-mass items of other isotopes	Large number of DOE, university, medical, and industrial sites	A wide variety of container types

Some or all of the inventories of each special isotope are judged to be "programmatic" materials that DOE wishes to retain for future use. As the defense reactor production mission has stopped, the potential source for significant quantities of byproduct isotopes has disappeared. Isotopes that will be retained must be stabilized in a safe, storable form for uses that may arise decades in the future.

Overview of Concerns

The largest inventories of several key isotopes remain in aqueous solutions at the chemical treatment facilities that formerly supported the defense missions. The liquid form is unsuitable for long-term storage, as it allows for the potential release of radioactive and/or hazardous materials to the environment and exposure to workers. Many of the same concerns that govern DOE's management of Pu-239 solutions (see Section 3.1) exist for special isotopes. Programs to stabilize and safely store special isotopes will follow similar pathways and involve similar facilities. In some cases (e.g., Am/Cm stabilization), process development is necessary to demonstrate the large scale stabilization process and the stability of the proposed storage form.

Solids of special isotopes are generally part of active inventories or are stored in small quantities. Many are encapsulated or stored in sealed containers. However, one category of solids for which concern has been raised is Pu-238 oxides stored at Savannah River in configurations that were not intended for long-term management. Repackaging is required to ensure that these materials are not subject to failure stemming from helium ingrowth pressure buildup.

Applicable Sub-recommendations from DNFSB Recommendation 94-1:

Sub-recommendation 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 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.

Sub-recommendation 2:

That a research program be established to fill any gaps in the information bas needed for choosing among the alternate processes to be used in safe conversion of various types of fissile materials to optimal forms for safe interin storage and the longer term disposition. Development of this research progran should be addressed in the program plan called for in (1) [Sub-recommendation 1] above.

Sub-recommendation 3:

That preparations be expedited to process the dissolved plutonium and trans-plutonium 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.

Acceptance and Objectives

The DOE fully concurs with the Board's observations and recommendations relative tc the stabilization of trans-plutonium isotopes in Savannah River's F-Canyon, and extends the program to include Pu-242 and neptunium solutions in Savannah River's H-Canyon. Concerns about the packaging of Pu-238 materials, identified during the Plutonium Vulnerability Assessment, will also be dealt with in concert with the program for the management of Pu-239 materials. Components of this program include:

- Improving surveillance and monitoring for actinide solutions stored at Savannal River, and implementing measures to manage risk until long term storage form can be produced.
- Establishing firm criteria for product forms and storage containers for solids resulting from solution stabilization and implementing necessary research and testing.
- Accelerating repackaging Pu-238 solids currently in inadequate storage configurations.

- Establishing an integrated program to define long term storage and utilization goals for byproduct isotopes; identifying amounts that will be retained or discarded; and establishing programmatic ownership for long term management.

Inventory-specific objectives include:

- Immediately discontinuing active water cooling for americium-curium solutions in Savannah River's F-Canyon, eliminating the greatest environmental exposure pathway risk for continued storage **[completed]**.
- Completing process development, conceptual design, construction and startup for americium-curium solidification facility at Savannah River, and completing stabilization of the Am/Cm solution by September 1998.
- Implementing effective surveillance and monitoring programs to reduce the risk extended storage of special isotope solutions.
- Stabilizing Pu-242 solutions at Savannah River's HB-Line Phase III following Pu-238 campaign, with completion by November 1997.
- Completing neptunium processing to final storage form for storage in new shielded vault array by the end of 2002.
- Accommodating special isotopes that will be separated or recovered from the plutonium bearing materials and fuel processing activities outlined in other sections of this plan.
- Venting Pu-238 solids that are stored under adverse conditions in Savannah River's Building 235-F by April 1995 in preparation for repackaging.

Key Assumptions

- Special isotopes may have future programmatic use, thus these materials should be prepared for long term storage, pending future use
- The ROD for the Interim Management of Nuclear Materials (IMNM) EIS will support implementation of the options presented in this plan for Savannah River materials.
- Storage, shipment, and specification issues associated with these materials will be resolved.

Part II: Special Isotopes Integration Activities

Approach

Most of the identified materials are stored at Savannah River, where interim stabilization measures must be performed. The Department will integrate the program through the development of long-term storage and use requirements with programmati customers and the designated long-term storage sites, including Los Alamos (Pu-238 and Pu-242) and Oak Ridge (Am/Cm and isotopes controlled by the Isotope Production and Distribution Office).

The key functions required to be in place to adequately address the special isotope issues are shown in Figure 3.4-1: Management of Special Isotopes and are summarized as follows:

- Continue, improve, and formalize compensatory surveillance and monitoring activities to assure safe storage conditions are maintained.
- Stabilize actinide solutions on a priority basis. If solutions must be treated in sequence, develop treatment schedules that recognize the relative risks of existing conditions and the availability of storage facilities for stabilized solids
- Establish criteria (form and packaging) for long-term storage of solid special isotopes that will be retained for future use.
- Develop and demonstrate solidification technologies, as required, to meet long term storage criteria.

Timing for isotope solidification and storage improvements will be prioritized with a risk-based approach, recognizing that many of the facilities that are required to mitigate concerns with Pu-239 and uranium materials must also be used to deal with special isotopes.

<u>Reserve Requirements</u>: Strategic goals will be refined for w' :h parts of current inventories must be retained for future use. The Departmen . Office of Defense Programs will define isotope quantities and forms that will be reserved for national security needs. Non-defense users will define requirements for programmatic and National Asset reserves, in concert with DOE representatives (including the Office of Nuclear Energy). Inventories in excess of these requirements will be considered for long-term storage or disposal, depending on the best mixture of technology, risk factors, and costs. Under current guidance, all of the Am/Cm, Pu-242, and Pu-238, and Np-237 stored at Savannah River would be retained.

MANAGEMENT OF SPECIAL ISOTOPES

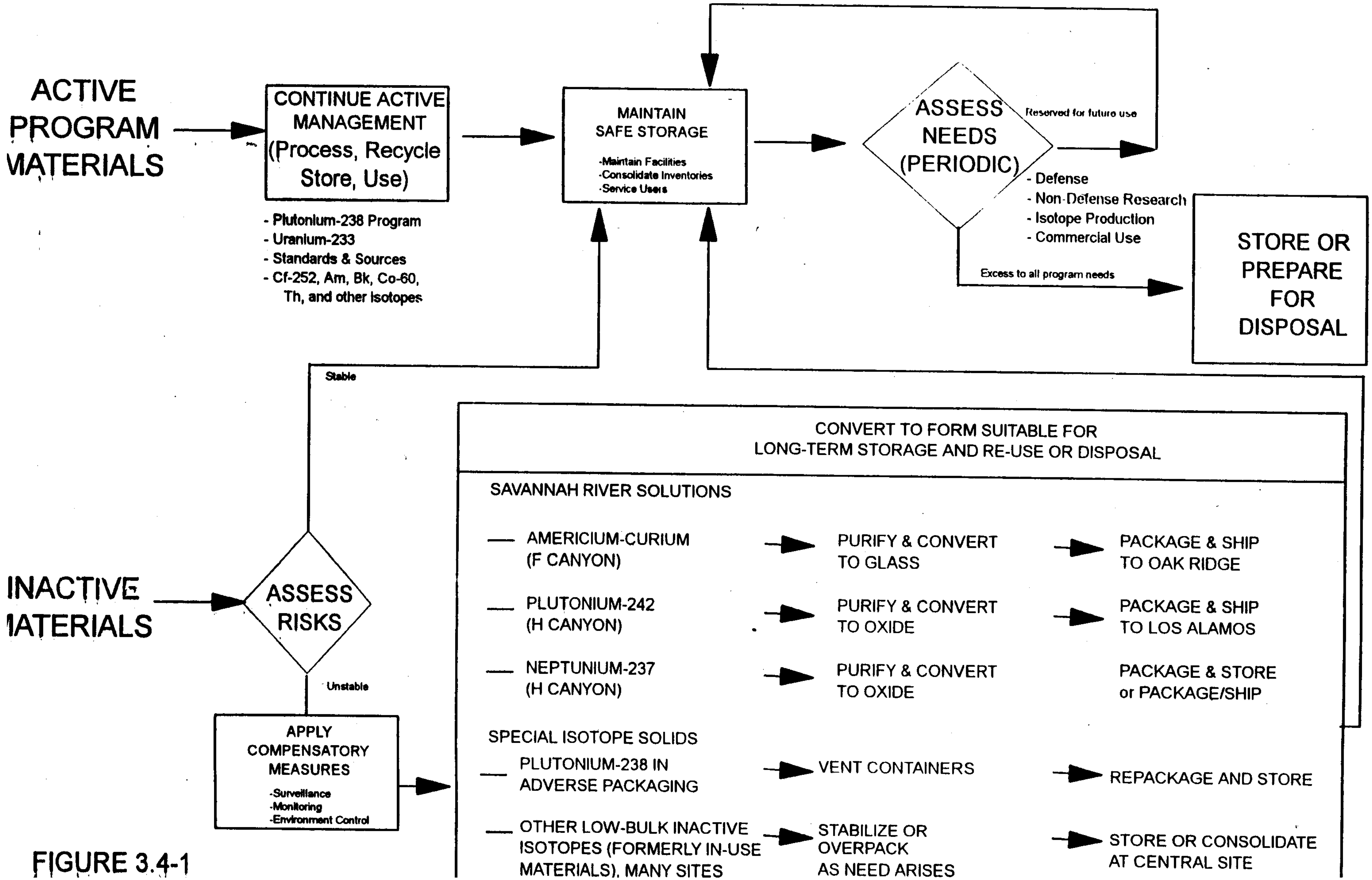


FIGURE 3.4-1

Storage Requirements: Storage form will be determined based on long-term safety isotopic accessibility to user programs. Stable oxides are considered suitable for all major isotopes, although alternative forms (like glass for americium-curium) may be preferable. Special containers and shielded storage arrays must be developed and procured for high-radiation isotopes (e.g., neptunium).

Key Challenges

- Acceptable end-states for long term storage of isotopes that will be retained must be fully developed.
- Inventories that are excess to program needs must be defined, with prioritization of stabilization-versus-disposal decisions.
- Acceptable storage space must be established, and shipping and storage containers developed for neptunium oxide.
- Development and demonstration of vitrification technology for americium/curium stabilization must continue to be successful.
- A strategy for dispositioning special isotopes from smaller government, industrial, and university sites is needed in order to optimize use of complex-wide capabilities while treatment capabilities are still available.

In recognition of the challenges, activities will be initiated to:

- Clarify end-states and disposition pathways
- Establish storage standards and/or criteria for unique material forms as require
- Resolve transportation, storage space, and consolidation issues related to speci isotopes.

Part III: Individual Site Activities

3.4.2 Savannah River Americium-Curium Solution

Special Isotopes at Savannah River includes 14,400 liters of aqueous solution in a single tank in F-Canyon. The americium-curium solutions cannot be stabilized within the three year period recommended by the Board because of the lack of capability and the need for process development. However, to address the urgency of the storage conditions, DOE has implemented compensatory measures that have reduced risks to workers and the environment to acceptable levels, pending completion of the program to convert the solutions to a stable solid. The Department judges the americium and curium to be programmatically important, and plans to retain stabilized solids for use in the DOE's National Heavy Element and Advanced Neutron Source programs.

The radioactivity levels associated with the americium-curium make it necessary that this material be stabilized to a solid form within the heavily shielded F-Canyon building. The Am/Cm represents about 90% of the potential radiological hazard of solutions currently stored in F-Canyon. A process in F-Canyon was used previously (in the early 1980s) to convert small quantities of Am-241 to an oxide. However, this process equipment has not been maintained and would require extensive modification to produce either a borosilicate glass or oxide.

The IMNM EIS will evaluate options for stabilization of the F-Canyon americium-curium solutions to a storage form suitable for future use. The EIS ROD is expected by July 1995. In addition to "no action", options being considered include continued storage under active management until new facilities and processes are installed in F-Canyon to vitrify, or solidify as an oxide. The vitrification alternative is to produce a glass form to be shipped to Oak Ridge for storage and eventual recovery of the americium and curium. The task includes a process development and test program to develop information on the flowsheets for solidification and the stability of the solid product. Concurrently, facilities in F-Canyon must be renovated to allow the stabilization equipment to be installed, requiring several years to complete. If this option is selected, solutions would be stabilized by September 1998.

The site has implemented measures that will reduce the hazard until full stabilization is achieved. The major vulnerability is related to a potential for tank cooling coil failure coupled with detection delay errors, resulting in significant release of radioactivity. Savannah River has determined that the solutions no longer require active water cooling and has thus mitigated this potential source of risk by disconnecting the cooling coils. A monitoring and surveillance program continues, including tank sampling and evaluation of the potential for actinide precipitation.

The stabilization program includes: restarting and operating F-Canyon; completing bench process development work and conceptual design for solidification facility by December 1995; installing equipment in the renovated Multi-Purpose Processing Facility at F-Canyon; testing equipment in the cold facility and installing a new process line; and developing procedures for remote handling, canning, decontamination, and cask loading of product canisters for offsite shipment.

3.4.3 Savannah River H-Canyon Plutonium-242 Solution

Savannah River holds approximately 13,300 liters of aqueous solution of Pu-242 in a single tank in the H-Canyon chemical treatment facility. The site also stores three containers, with small quantities of oxide, in the F-Area Laboratory (Building 772-F). Plans are being developed to stabilize this small quantity of Pu-242 oxide.

Plutonium-242 has a programmatic customer, and the goal is to convert it to a form suitable for shipment to that customer and for interim storage. The options for converting this material are to process the solution in H-Canyon to remove impurities, then to concentrate the solution and transfer it to Savannah River's HB-Line Phase III for conversion to an oxide; or to continue storage under active management (no action). The vehicle for deciding the course of action is the IMNM EIS, with the ROD expected July 1995. Converting this solution to an oxide would be the quickest way to stabilize this material while meeting the programmatic need. Assuming this alternative is selected, stabilization would proceed no later than May 1997 and would be completed within six months, by November 1997.

The continued storage of this material in solution form would result in safety concern similar to those for other highly radioactive solutions, however, to a lesser degree. The Pu-242 solutions have been in storage longer than originally envisioned. Preventing deterioration in solution chemistry requires mitigating actions, including increased sampling and surveillance, to reduce the potential for equipment failure and radioactive release. Undesirable events could result from the inherent vulnerabilities associated with extended storage, such as releases from spills or leaks and transfer errors that could occur while maintaining these solutions.

3.4.4 Savannah River H-Canyon Neptunium Solution

As with the Pu-242, Np-237 has a potential programmatic need, in this case as a targe material for production of Pu-238 for use as a fuel for radioisotope thermo-electric generators in spacecraft as well as terrestrial applications. Savannah River Site holds 6000 liters of neptunium nitrate solution in H-Canyon. The options for material stabilization are as discussed above for Pu-242, except that Phase II of HB-Line wc be used rather than Phase III. Again, the course of action will be governed by the IMNM EIS, and the plan outlined here assumes that the processing alternative is selected. Other alternatives under consideration include continued storage under activ monitoring (no action), disposal to the Savannah River Site high-level waste systems, or vitrification.

HB-Line Phase II was constructed in the mid-1980s but never operated, and several years would be required to prepare the facility for start-up in accordance with current requirements (e.g., DOE Order compliance, safety documentation, training, etc.). Phase II will be used to solidify Pu-239 solutions that also are stored in H-Canyon (se Section 3.1) and for stabilization of mixed oxides and residues, and the facility is not expected to be available for neptunium solution until late 2001. This delay may not affect the "critical path" schedule, however, because special provisions for storage of the resultant neptunium oxide, including new storage containers and shielded storage space, are also required due to radiation levels associated with the in-growth of protactinium. Feasibility studies are underway to determine the most cost-effective method of storage. These studies are evaluating acceleration of HB-Line Phase II restart; new storage facilities; and upgrades of existing storage facilities beyond the year 2000.

Other storage options including consolidation of neptunium oxide storage at a single site are being evaluated under the Fissile Materials Disposition Programmatic EIS. No firm criteria have been developed for long term storage of neptunium oxide;

however, development of a configuration that provides protection equivalent to the DOE standard for long term storage of Pu-239 metals and oxides should be straightforward.

While the neptunium solutions await disposition, activities to reduce the potential for release to the environment and to reduce the risk of criticality include: an expanded and formalized sampling and monitoring program; pressurization and monitoring of the cooling water supplied to the solution storage vessels; and physical isolation of the cooling system to ensure no radioactivity is released to external systems. Restart of support facilities in adjacent parts of H-Canyon will also greatly reduce the risks of continued, monitored solution storage. Expanded treatment, chemical adjustment, agitation, and solution movement options will be available in case deficiencies are noted in current storage conditions.

During the neptunium solution stabilization, Savannah River also plans to solidify any neptunium recovered during treatments of mixed plutonium-neptunium solids and irradiated fuels, four containers of neptunium oxide scrap, and (if treatment is required for programmatic users) unirradiated neptunium-aluminum reactor targets that are currently stored at the site.

3.4.5 Plutonium-238 Solids

The DOE is managing a program to recover, purify, solidify, and fabricate Pu-238 for use in radioisotope thermo-electric generators. The largest application for these generators is as power sources for NASA deep space missions.

The main inventories are effectively managed with active processing and production programs at Los Alamos, Mound, and Savannah River. However, one category of inventories was shown to be stored under significantly adverse conditions during the Plutonium Vulnerability Assessment performed by DOE's Office of the Environment, Safety, and Health. This category includes certain materials stored in Building 235-F at Savannah River where the primary containment vessel was found to be potentially susceptible to pressurization due to helium buildup from alpha decay. The Department has taken immediate steps to mitigate this vulnerability. All such Pu-238 materials will be transferred to the Savannah River HB-Line facility by April 1995, where the primary containment vessel will be vented into a protected glovebox line, and the containers will be repackaged.

3.4.6 Other Special Isotope Concerns

The Department manages many items that hold special isotopes, including a wide arr of standards and sources. These items are not major safety drivers for the DOE Implementation Plan related to Recommendation 94-1. However, DOE expects that demand will continue for DOE to supply these materials and to accept items that are no longer needed by user programs. Many of the facilities and processes that traditionally serviced non-defense isotope requirements are located at former defense nuclear facilities. Future demands on those facilities are not completely defined.

Los Alamos is operating a program to receive and treat Pu-239-beryllium sources tha are no longer needed, and programs are also being developed to deal with more than 10,000 excess americium and Pu-238 sources.

The Department commitments may be achievable using small, bench-scale and glovebox operations to support the reduced support missions for isotopes. Besides th isotopes listed above, DOE has also supported research involving curium, berkelium, californium, neptunium, thorium, and U-233. Any demands on the facilities used to treat the materials identified in Recommendation 94-1, will also be factored into the schedule and funding requirements for the complete program to deal with nuclear materials that are excess to national security needs. No major impacts would be expected on the DOE's support for the utilization of non-actinide materials, which have included Co-60, Ni-63, Sr-90, Cs-137, and a wide range of medical and resea isotopes.

3.4.7 Key Milestone Schedule

The following schedule milestones are contingent upon the outcome of the Savannah River IMNM EIS.

- Start vitrification of Am/Cm solutions at Savannah River in March 1998 and complete in September 1998.
- Pending completion of Pu-238 campaign, begin stabilization of Pu-242 solutions at Savannah River's HB-Line Phase III in May 1997, with all solutions stabilized by November 1997.
- Begin stabilization of Np-237 solutions at Savannah River's HB-Line Phase II in July 2001, with all solutions stabilized and stored in new packaging by the end of 2002.
- Transport Savannah River's Pu-238 solids currently in inadequate storage to th HB-Line by April 1995 for venting and repackaging.

3.5 Uranium

Part I: Stabilization Requirements

3.5.1 General Overview

Background

The Department currently manages significant quantities of enriched uranium. This material exists in a number of configurations, including materials left in the production cycle. Although highly enriched uranium (HEU) was not specifically identified in DNFSB Recommendation 94-1, this section provides a description of the required stabilization activities.

This section does not address long-term storage or disposition of weapons-useable fissile materials (including HEU), naturally occurring uranium, depleted uranium or low enriched uranium. The decisions for long-term storage or disposition of weapons-useable fissile materials will be determined through the Programmatic EIS for Storage and Disposition of Weapons-Usable Fissile Materials, the EIS for surplus HEU and other materials, and the associated RODs.

Table 3.5-1: Materials Requiring Stabilization

Site	Material Group	Location	Quantity
Savannah River	HEU Solution	Building 221-H	230,000 liters
Rocky Flats	HEU Solutions	Building 886	569 kgs of U-235 contained in 2,700 liters
Oak Ridge	HEU Solids	K-25 Building	Less than 100 items each with >500 g HEU located in an unfavorable geometry
Oak Ridge	HEU Solids	Molten Salt Reactor Experiment	Bulk salt inventory of 4,650 kgs (containing 31 kgs U-233, 1 kg U-235, 1 kgs Pu)

This section also does not address interim storage of enriched uranium at the Y-12 Plant in Oak Ridge With the virtual cessation of weapons production, the Departme has proposed that EU be shipped to Y-12 for processing into a safe, storable form, an to be placed in interim storage above final disposition is determined through the PEIS for storage and disposition of Weapons-Usable Fissile Materials.

until?

In September 1994, a draft "Environmental Assessment (EA) for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge Tennessee" was prepared. The Department is reviewing stakeholder and the State of Tennessee's comments on that EA.

Overview of Concerns

The Department manages significant quantities of HEU in solution at Rocky Flats and Savannah River. The liquid form is not suitable for long-term storage, as it allows fo the possibility of releases to the environment, exposure to workers, or unplanned criticality. Storage arrays must be controlled or solution dilution must be maintained to preclude the formation of critical configurations. The extended storage of these solutions also precludes the timely deactivation of these facilities, thus requiring the continued high cost for surveillance and maintenance activities to maintain facility safety envelopes. In addition to reducing the safety risk, the stabilization of these solutions would reduce the proliferation risk because the HEU content would likely be blended to a low-enrichment level.

Several DOE programs that supported reactor fuels cycles and defense research generated solid residues. Such residues remain at Oak Ridge facilities, INEL, Los Alamos, and various smaller sites. Some of these residues are reactive, and could possibly generate toxic or hazardous conditions, and in some cases pose an unnecessary risk for unplanned nuclear criticality. Additional details associated with these concerns are addressed in the individual site sections. The Department has not formally assessed the vulnerability of uranium materials; however, the risk posed by these materials is substantially less than that from the plutonium materials and spent nuclear fuels. As additional vulnerabilities are identified during these upcoming assessments, appropriate action will be taken pursuant to the appropriate NEPA analysis.

Applicable Sub-recommendations from DNFSB Recommendation 94-1

Sub-Recommendation 1:

> *That an integrated program plan be formulated on a high priority basis, to convert within two or three years the materials to forms or conditions suitable for safe interim storage.*

Acceptance and Objectives

The DOE concurs with the DNFSB recommendations and has established the following objectives, subject to appropriate NEPA analyses:

- All HEU uranyl nitrate solutions will be removed from Building 886 at Rocky Flats by September 1996 and shipped off-site for conversion to a safe stable forms.

- All existing unstable HEU solutions at Savannah River will be blended down to a low enrichment and then converted to an oxide form by December 1997.

- Mechanical removal of HEU deposits will be completed at the Oak Ridge K-25 site, which includes about 66% of total items containing deposits greater than 500 kg HEU located in an unfavorable geometry, by September 1997. Chemical removal of remaining HEU deposits will be pursued aggressively and completed in April 1999.

- HEU Uranium deposits from Oak Ridge National Laboratory (ORNL) Molten Salt Reactor Experiment (MSRE) project will be removed by February 1998. Compensatory measures were put in place November 1994 to mitigate a potential accidental criticality caused from water entering the auxiliary charcoal bed (see Section 3.5.4.)

Key Assumptions

- The decisions made pursuant to the NEPA process will be consistent with the options used to develop the schedules for uranium stabilization.

- The standard for interim storage of uranium metal and oxide will be as stated in the draft criteria currently being developed.

- The HEU solutions are excess to national defense requirements.

Part II: Uranium Integration Activities

Approach

- An integrated, complex-wide approach will be used to determine schedules, costs, and ultimate conversion of the uranium materials. Uranium solutions will receive priority for aggressive disposition to safe, storable forms. The inter-site team approach has proven successful, and will be accelerated. Typical material flows and projected transfer times are noted in Figure 3.5-1.

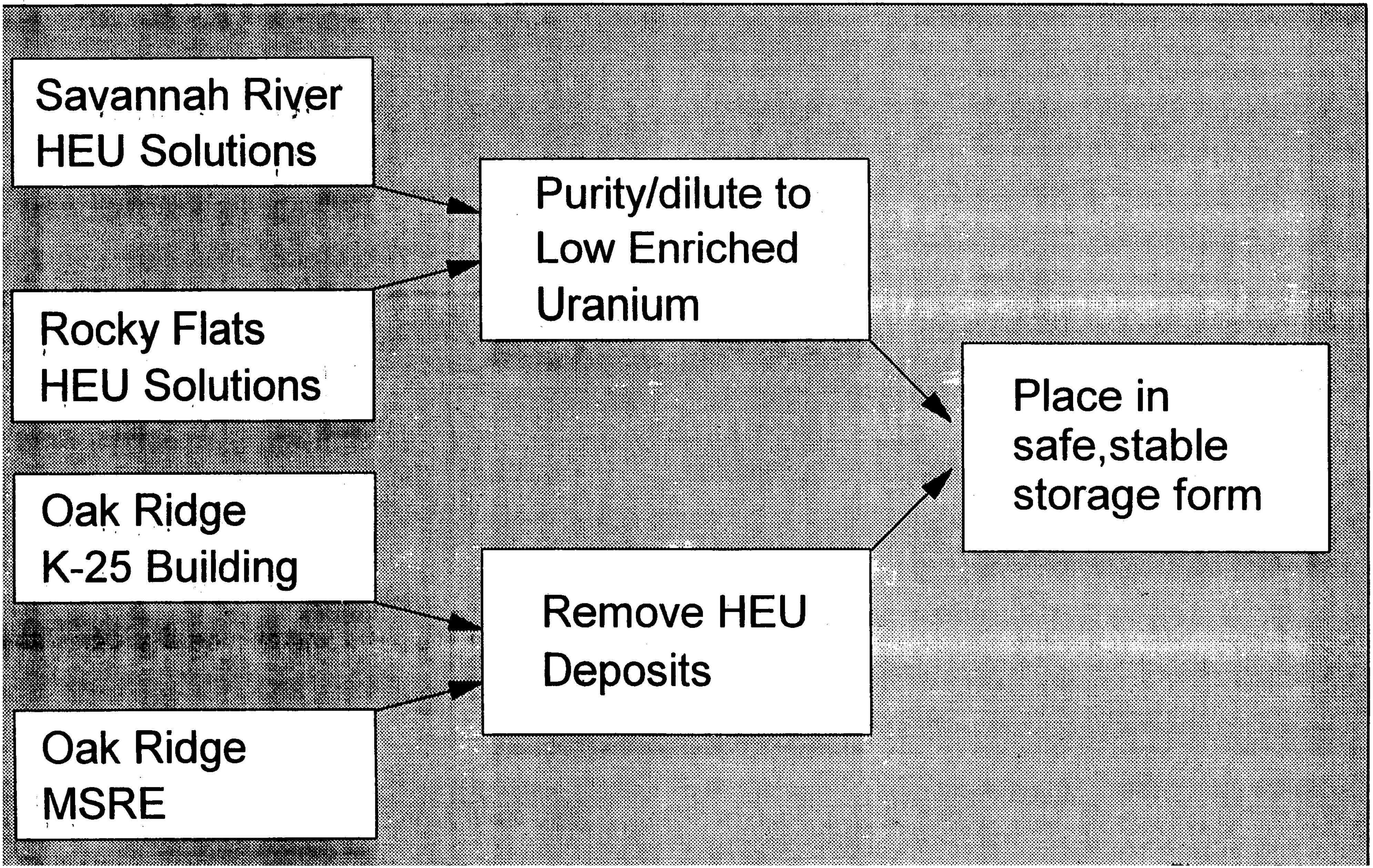
Key Challenges

- Issue a DOE Standard for safe storage for uranium.
- Improve material characterization, consolidation, inventory techniques, and handling techniques to reduce exposure to operators, minimize waste, and reduce overall costs.
- Develop innovative packaging and shipping techniques to optimize material transfer to storage facilities.

In recognition of these challenges, activities will be initiated to:

- Develop a summary of specific facilities and worker talents needed to achieve the stabilization and interim storage of uranium containing materials.
- Develop and issue a Department Standard for the safe interim storage for uranium.
- Develop a single complex-wide strategy for interim storage of stabilized uranium.

HEU STABILIZATION LOGIC



Part III: Individual Site Activities

3.5.2 Uranium Solutions at Rocky Flats

Rocky Flats is currently storing approximately 2,700 liters of highly enriched uranyl nitrate solution (HEUN), containing 569 kg of U-235 in eight Raschig ring tanks in Building 886. In its present storage configuration, these solutions present a potential criticality safety hazard based on continued long term storage and various postulated accident scenarios. The objective is to convert these solutions to low enriched solids suitable for storage.

Rocky Flats expects to use the services of a contractor with a specialized uranium processing expertise to prepare and remove the HEUN from Building 886, converting the solution to a form acceptable for interim storage. The contractor would provide portable skid-mounted blending equipment that would be connected to the existing HEUN storage tanks. This equipment has been licensed for blending of HEU solutions. Once isotopically diluted, the solutions would be shipped to the contractor facility in trucks licensed by the Nuclear Regulatory Commission and Department of Transportation. Approximately six shipments would be required. The contractor would convert the low-enriched solution to a stable oxide and then deliver the materi to an approved storage location.

Prior to initiating draining and blending activities in Building 886, extensive correc maintenance, safety analysis, personnel training, and facility readiness review activitie must be completed. Blending and shipment work will begin in May 1996 and includ blending of the material, shipment to the contractor's facility, conversion, and final delivery to the storage location. Completion of all shipments to the final storage location will occur prior to September 30, 1996.

3.5.3 Uranium Solutions at Savannah River

Highly Enriched Uranium

Savannah River holds 230,000 liters of highly enriched uranium in dilute nitrate solutions in the site's H-Canyon processing facility. This inventory consists of active "in-process" solutions that remained after chemical processing and separation of spent nuclear fuel were suspended. The solutions posed a minor hazard while connected processes were operating, but solutions are not suitable for long-term storage of exces uranium. Continued storage would raise the risks of unplanned releases of radioactive materials to the environment, increased exposure to facility workers, or exposure to th public. An active monitoring and surveillance program is expected to maintain solutions under safe conditions until they can be treated for long term disposition. Options for stabilizing these solutions are being considered in the Interim Managemen of Nuclear Materials (IMNM) EIS. The Record of Decision is expected to be issu in July 1995.

One stabilization method cited in the IMNM EIS is to process solutions through H-Canyon to separate the enriched uranium from impurities and fission/decay products and transport depleted uranium solutions from F-Canyon (either existing solutions or additional solutions made by dissolving depleted uranium oxide in FA-Line). The resulting stream would then be blended to less than 1% U-235 before transporting it to FA-Line for conversion into oxide for on-site storage. If this option is selected, treatment is straightforward, and the schedule depends largely on construction time for the blending facilities and transportation interfaces, restart activities, readiness reviews, and the availability of funding and technical resources. Construction completion is projected for July 1996, with blending and processing into oxide to be completed by December 1997.

The Department also is evaluating a stabilization method in which the solutions would be diluted to less than 20% U-235 and shipped off-site to commercial fuel fabricators, which would produce power-reactor or research-reactor fuel from the stream. The EIS is also evaluating the completion of the Uranium Solidification Facility, continued storage of the solutions under active management, and disposal by discharge to high-level waste tanks as well as options for stabilizing existing depleted uranium solution.

Major challenges include the allocation of key skilled personnel between restart efforts and operations at both F- and H-Canyons at Savannah River. The proposed plan would use existing facilities and processing technology. In the interim, increased and formalized monitoring and sampling programs are expected to reduce the risk of continued storage to an acceptable level, pending completion of the stabilization program.

3.5.4 Uranium Residues Needing Stabilization at Oak Ridge

Molten Salt Reactor Experiment (MSRE)

The Molten Salt Reactor Experiment operated from 1965 through 1969 to investigate molten salt reactors for commercial power applications. The reactor used a fluoride salt mixture of lithium, beryllium, and zirconium fluorides, with uranium tetrafluoride as the fuel component. Initially, the reactor was fueled with U-235, which was later replaced with U-233 in 1968. Less than 1 kg of plutonium trifluoride was added in 1969. When the reactor was shut down, the fuel salt was drained into two fuel drain tanks in the drain tank cell, where it cooled and solidified. Following a post-operation examination, the facility was placed under a program of surveillance and maintenance (S&M) awaiting eventual decontamination and decommissioning (D&D). Radiolysis of the fuel salt was expected to slowly produce fluorine (F_2) gas after a latent period. A procedure to anneal the salt annually was developed as part of the S&M program. In the late 1980s, radiological surveillance at the facility indicated elevated radiation in the North Electric Service Area (NESA) on piping connected to the drain tanks.

A visible release of an unidentified gas also was observed from the off-gas system piping in the vent house during a maintenance operation. This indicated that contamination associated with the stored fuel salt may have migrated from the drai tanks. Plans were developed and initiated to investigate the migration problem and determine appropriate mitigative measures. Gas samples taken from the vent house indicated significant concentrations of uranium hexafluoride (UF_6) and F_2. Radiation readings in the adjacent charcoal cell also determined a significant deposit of solid uranium in the inlet section of the auxiliary charcoal bed (ACB). The ACB section containing the uranium deposit was under water originating from the designed shutdown. If water were to have entered the ACB and migrated to the deposit, the potential for an accidental criticality could not be eliminated.

As a result of these discoveries, a comprehensive plan was established and put into place to initiate interim corrective measures (drain water from the ACB cell, partition the off-gas system, and eliminate water sources); remove the uranium deposits; and dispose of the fuel salt. The interim measures will be completed by November 1995. The uranium deposits will be removed by February 1998, and the fuel salts by May 2000.

Deposit Removal Project at the K-25 Site

During the operating life of the K-25 facilities, isotopically highly enriched uranium accumulated inside equipment and piping as a result of wet air in-leakage. The K-25 Building was initially shut down in 1964. In 1985 it was determined that the gaseous diffusion facilities were in excess of uranium enrichment needs, and they were plac on standby. The decision was made to permanently shut them down in 1987. Deposits of enriched uranium remain in the piping and equipment. Based on field nondestructive assay (NDA) measurements, it was determined that some of the HEU deposits present an unacceptable criticality risk based on requirements currently defined in DOE Order 5480.24, *Nuclear Criticality Safety*. In 1989, steps were taken in the field to reduce the likelihood of a criticality event by welding openings in the process piping that could have allowed water in-leakage, and by isolating specific piping and equipment of concern.

The Deposit Removal Project was initiated to remove the HEU deposits from piping and equipment in the K-25 Building. The project's scope includes removal of deposit containing greater than 500 g quantities of U-235 (unsafe mass) in an unfavorable geometry from target items such as pipes, compressors, cold traps, chemical traps, surge tanks, and convertors (Whitehead and Type II). Completion of this project should bring the building into compliance with the DOE Order 5480.24 requirement that the probability of a criticality be less than 10^{-6}. Subsequent actions are planned for removal of smaller quantities of HEU, which present a criticality risk of less than 10^{-6}. Removal of deposits began in FY95 and will be accomplished by using mechanical and chemical methods. Mechanical removal of HEU deposits will be completed by the September 1997 date that DNFSB recommended. This removal will include about 66% of the items containing deposits greater than 500 kg HEU located in unfavorable geometry. Chemical removal of the remaining HEU will be complet by April 1999.

3.5.5 Key Milestones

Rocky Flats

- Begin shipping HEU solutions off-site for stabilization . . . . May 1996
- Remove HEU solutions from Rocky Flats . . . . September 1996

Savannah River

- Record of Decision for Interim Management of Nuclear Materials . . July 1995
- Convert 230,000 liters of HEU solutions to a stable oxide . . . December 1997

Oak Ridge

Molten Salt Reactor Experiment

- Complete corrective interim measures . . . . November 1995
- Remove uranium deposits . . . . February 1998

K-25 Site

- Complete mechanical removal of uranium deposits . . September 1997
- Complete chemical removal of uranium deposits . . . . April 1999

3.6 Spent Nuclear Fuel

Part I: Stabilization Requirements

3.6.1 General Overview

Background

This section addresses only specific concerns highlighted by the Board involving spent fuel located in the K-East Basin at the Hanford Site, the CPP-603 Basin at the Idaho National Engineering Laboratory (INEL), and the processing canyons and reactor basins at the Savannah River Site (SRS). This material represents a significant subset of the total inventory of spent nuclear fuel (SNF) managed under the DOE SNF Program. However, other major elements of the SNF Program are briefly described in order to place the concerns of the Board in context of the overall program.

SNF is nuclear fuel or targets containing uranium, plutonium, or thorium withdrawn from a nuclear reactor or other neutron irradiation facility following irradiation, the constituent elements of which have not been separated by chemical reprocessing.

These materials include essentially intact fuel and disassembled or damaged units a pieces; irradiated reactor fuel, production targets, slugs, and blankets presently in storage or that will be accepted for storage at DOE facilities; debris, sludge, small pieces of fuel, and cut up irradiated fuel assemblies subject to evaluation of their waste classification.

The inventory of DOE-owned SNF is composed of approximately 2,700 metric tons of initial heavy metal as shown in Table 3.6-1. Planned additions to existing inventories will come from naval reactors, U.S. research reactors, and other government reactors. DOE may accept responsibility for some spent fuel resulting from the operation of research reactors located overseas that operated using fuel containing uranium of U.S. origin. This foreign research reactor SNF represents a potential addition to existing DOE inventories. The combination all of these possible additions to SNF inventories through the year 2035 is estimated to be 97 metric tons, which represents less than 4 percent of the existing inventories.

Overview of Concerns

The vast majority of DOE-owned SNF was designed to be reprocessed and is therefore susceptible to dissolution in aqueous solutions. Long-term storage in the underwater fuel storage facilities was not intended for the majority of the spent fuel. The storage facility engineering design and the monitoring requirements were not adequate to compensate for the various underwater corrosion mechanisms experienced due to the extended storage. Severe unintended consequences have resulted, including the loss configuration control of the storage equipment; the failure of cladding, which affects criticality safety, sludge generation, and fuel handling; and radionuclide leakage into the basin water, which affects personnel exposure and increases potential environmental impacts.

Because these facilities were designed between 30 and 50 years ago, most do not meet all current standards for seismic resistance to prevent potential fuel reconfiguration or current standards for leak protection and detection. A design basis seismic event may result in reconfiguration of fissile material and potential criticality, worker overexposure, and leakage to the environment. Inaccurate leak detection and adequate barriers to leakage could result in unmonitored releases of radioactive material to the environment.

Generally, much of the spent nuclear fuel and targets are inadequately characterized. Additionally, DOE did not update the safety authorization to address long-term storage of the degrading material. Upon the decision to phaseout reprocessing in April 1992, the Department lacked an integrated approach for transitioning from short-term to long-term storage. The lack of characterization for the spent fuel and targets and the lack of a path forward for ultimate disposition resulted in delays in establishing methods for future safe handling, transport, and storage.

In its May 26, 1994, letter to the Secretary of Energy, forwarding Recommendation 94-1, the DNFSB was "*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.*" The Board highlighted specific concerns with irradiated reactor fuel located in the K-East Basin at Hanford, the CPP-603 Basin at Idaho, and the processing canyons and reactor basins at Savannah River. The Board was "*concerned about the slow pace of remediation*" and provided several recommendations to expedite the remediation of their concerns.

Applicable Sub-recommendations

The following specific recommendations relate to spent nuclear fuel:

Sub-recommendation 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.*

Sub-recommendation 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.*

In August 1993, the Secretary requested that the Spent Nuclear Fuel Working Group—made up of site personnel and participants from the cognizant Secretarial Offices, Operations Offices; the National Laboratories, and the Office of Environment, Safety, and Health—assess the conditions of DOE SNF storage facilities. After studying the conditions at 66 facilities at 11 sites, the Working Group published the *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* (Volume I, November 1993, and Volumes II and III, December 1993). The Working Group Report identified a total of 106 vulnerabilities associated with the Department's spent nuclear fuel storage facilities. Although the Working Group found no conditions that required immediate action to prevent harm to the workers or the public, it did identify five DOE facilities and three burial grounds that warranted priority attention to avoid unnecessary increases in worker radiation exposure and cost during cleanup. In addition to the specific site vulnerabilities, the Working Group identified five generic issues that are common to many DOE spent fuel storage facilities. They are (1) the lack of approved and current authorization bases, (2) seismic design inadequacies, (3) the lack of programmatic ownership, (4) the lack of complete material characterization, and (5) the lack of a specified path forward including path forward for ultimate disposition. These generic issues were taken into consideration when developing individual action plans and will require careful consideration by all facilities during future planning and decision making activities.

Table 3.6-1: DOE Spent Nuclear Fuel Inventory Summary

Site	MTIHM	% of Total MTIHM	Total Mass (Metric Tons)	% of Total Mass	Volume (Cubic Meters)	% of Total Volume
Hanford	2,132	81	2,315	50	256	19
Idaho	261	10	1,492	32	702	53
Savannah River	206	8	546	12	164	12
West Valley	26	1	43	1	12	1
Ft. Saint Vrain	16	< 1	190	4	160	12
Other (LANL, BNL, ANL and SNL)	3	< 1	22	< 1	20	2
Oak Ridge	1	< 1	20	< 1	12	1
Total	2,645	100	4,628	100	1,326	100

Acceptance and Objectives

The Department agrees that the materials addressed by the Board should be convert into a form suitable for safe interim storage on a high-prio basis. The Departm has committed to resolving all vulnerabilities identified in the SNF Working Group Report.

Recommendation 94-1 essentially demands the acceleration of the resolution of safety issues identified in the SNF Working Group Report for selected SNF at Hanford, Savannah River, and Idaho National Engineering Laboratory. This represents a significant portion of the DOE-owned SNF inventory and is acknowledged as the fuel at highest risk. Resolving these SNF issues is the single highest priority within the Department's SNF Program. Changes to existing vulnerability action plans will be necessary, including shortening the schedules for resolving these issues when practical and ensuring the reallocation and reprioritization of sufficient funding to perform the work. The program has set the following objectives:

- Place all DOE-owned SNF in secure, safe interim storage.
- Remove all fuel from the Hanford K-Basins by December 1999.
- Complete stabilization via dissolution of the Savannah River Mk31 targets by September 1996 and dissolution of Mk16 and Mk22 SNF by November 1999. Complete conversion of the resultant uranium solutions by April 2000.
- Remove all fuel from the Idaho CPP-603 Fuel Storage Facility by Decembe 2000.

Key Assumptions

- An integrated R&D program will be continued as a means to overcoming the following technical shortcomings:

  a) Corrosion mechanisms of DOE-owned spent nuclear fuels
  b) Hanford Path Forward Conditioning Process for hydrided and corroded N-Reactor fuels from K-Basins
  c) Dry interim storage of DOE-owned SNF.

Part II: Spent Nuclear Fuel Integration Activities

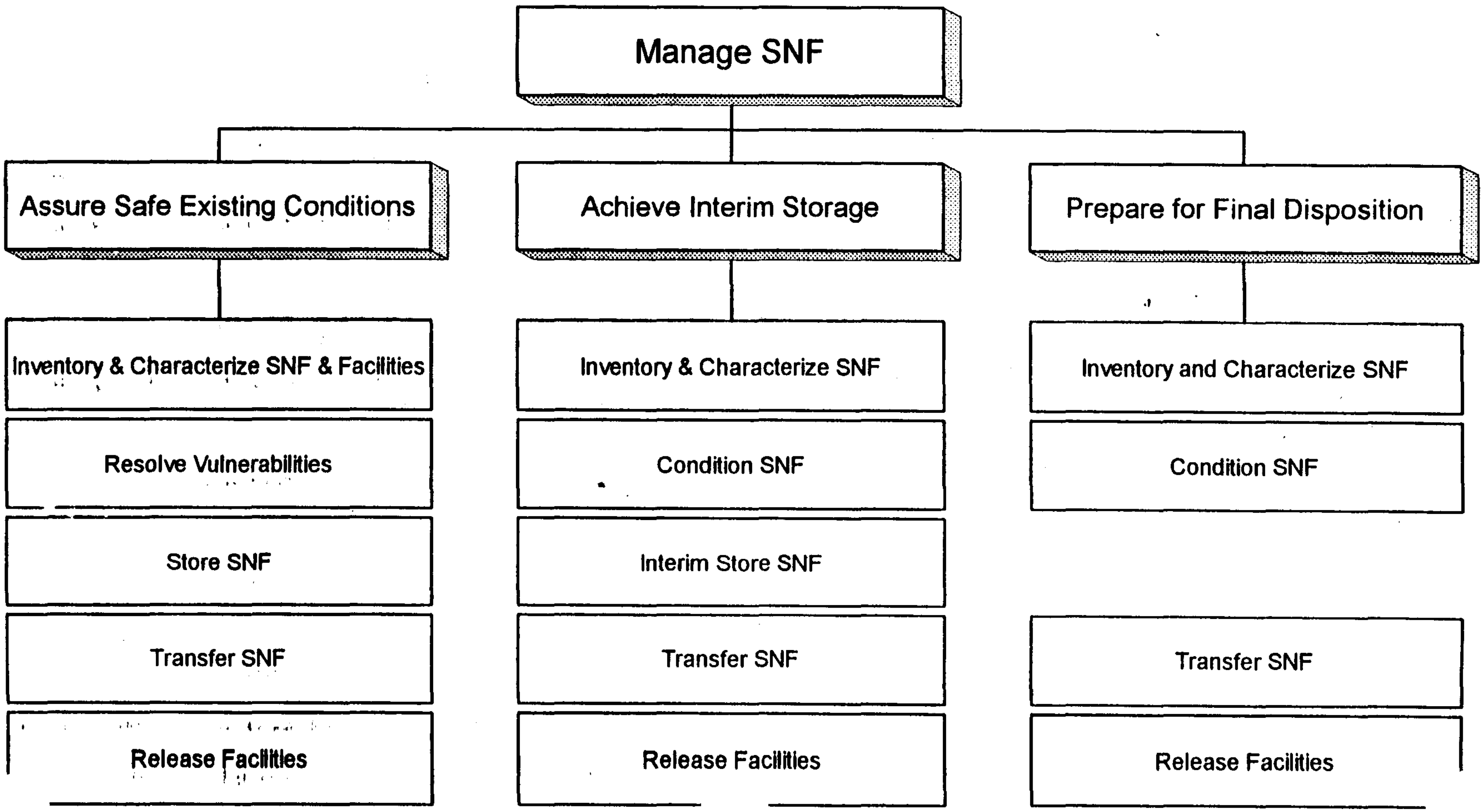
Approach

DOE's Spent Nuclear Fuel Program began in 1992, when the Secretary of Energy directed the Assistant Secretary for Environmental Management (EM) to develop an integrated long term SNF management program. This would consolidate under EM the management of DOE-owned SNF and associated facilities not addressed by the Office of Civilian Radioactive Waste Management (OCRWM). The EM Office of Waste Management is responsible for program direction for all DOE-owned SNF including SNF generated by DOE production, research, and development reactors; naval reactors; university and foreign research reactors (FRRs); other miscellaneous generators; and special-case commercial reactors. Within the Office of Waste Management, the Office of Spent Fuel Management provides strategic planning and policy for management of DOE-owned SNF. This overall guidance and policy is implemented through the line management operations organizations of the Offices of Waste Management and Nuclear Materials and Facilities Stabilization.

The strategies for achieving the mission of the SNF Program—to safely, reliably, and efficiently manage DOE-owned SNF and prepare it for disposal—are contained in several key Environmental Impact Statements (EISs) currently in preparation, and through the SNF Program Strategic Plan, which was issued December 1994. The EISs will provide the framework within which the SNF Program must operate. Details of the EISs are provided below. The SNF Strategic Plan is not intended to prejudice decisions on National Environmental Policy Act (NEPA) alternatives under consideration; rather, it sets out the broad objectives and strategies for achieving the program's mission within the framework established through the NEPA process.

A significant aspect of the Strategic Plan is the commitment to using a systems engineering process to provide sound program definition, management, and implementation. This process has been used to define the top-level functions and requirements needed to accomplish the SNF mission. The functions are shown in Figure 3.6-1. The *Spent Nuclear Fuel Systems Engineering Technical Functions (Levels 0, 1, & 2)*, published in December 1994, provides a more in-depth

SNF Program Systems Engineering Technical Functions



presentation of these functions and their interrelationships and their interfaces with the SNF Program. The *Spent Nuclear Fuel Program Requirements Document*, October 1994, delineates the top-level requirements for the SNF Program. The SNF Program Plan implements the SNF Strategic Plan and will be a combined Program Plan, Program Management Plan, and Systems Engineering Management Plan that defines the SNF program management process and technical approach, including implementation of the system requirements. It will specify and authorize a subset of implementing documents required to fulfill the SNF program strategic objectives, including the Stakeholder Involvement, Technology Integration, and Interim Storage Plans. The Technology Integration Plan was issued December 1994. The SNF Program Plan will detail the disposition of all DOE-owned SNF, including those fuelsaddressed in Recommendation 94-1 and the Spent Fuel Working Group Report. As previously noted, the Program Plan will serve as the SNF Material Integration Plan and incorporate schedules and milestones delineated by the Integrated Program Plan through the Site Implementation Stabilization Management Plans. The SNF Program Plan is scheduled for release in November 1995.

The Plan of Action to Resolve Spent Nuclear Fuel Vulnerabilities (Phase III, October 1994) addresses the resolution of the vulnerabilities addressed by the Spent Nuclear Fuel Working Group. It addresses all 106 vulnerabilities and provides the Department's baseline for corrective actions. The Phase III Plan of Action responds to the vulnerabilities identified in the SNF Working Group Report, and represents the completion of the Secretary's initiative to assess the Department's SNF facilities. The SNF Commitment Tracking System was developed to monitor commitments detailed in the Phase III Plan of Action and manage any new SNF issues which emerge. It is through these plans, functions and requirements that the resolution of vulnerabilities, as described in the SNF Working Group Report and Recommendation 94-1, is integrated and managed in concert with the interim and long-term objectives of the SNF Program.

DOE is committed to a comprehensive NEPA review process in making decisions on the storage, disposition, and, if appropriate, transportation of DOE-owned SNF. These decisions apply to:

- The interim management period pending ultimate disposition.
- Foreign Research Reactor SNF program-wide.
- Specific interim management of nuclear materials at the DOE sites.

The first set of decisions involves programmatic (DOE-wide) decisions regarding the appropriate locations of managing existing and projected quantities of SNF for an interim storage period that could last until the year 2035. This 40-year time frame was chosen to allow enough time to make and implement a decision on the ultimate disposition of all DOE-owned SNF. Accordingly, Volume 1 of the Programmatic SNF EIS addresses the potential environmental impacts associated with alternative sites for managing DOE-owned SNF for 40 years on a national level.

The siting of SNF management activities includes analysis of the following alternatives:

- No Action — take the minimum actions required for safe and secure management of SNF at or close to the generation site or current storage location.

- Decentralization — store most SNF at or close to the generation site or curren storage location with limited shipments to DOE facilities.

- 1992/93 Planning Basis — transport and store newly generated SNF at Idaho National Engineering Laboratory (INEL) or SRS.

- Regionalization — distribute existing and projected SNF among DOE sites based primarily on fuel type or geographic location.

- Centralization — manage all existing and projected SNF inventories from DOI and the Navy at one site until ultimate disposition.

Volume 2 of this EIS addresses the alternative approaches for management of DOE's SNF activities over the next ten years at INEL and includes fuel receipt, transportation, characterization, stabilization, storage, and technology development fo ultimate disposition.

The final Programmatic SNF EIS is scheduled for issuance by April 30, 1995, following review and revision based on stakeholder comments with a Record of Decision planned for June 1995. Site-specific NEPA reviews will tier from the Programmatic SNF EIS.

The second set of decisions involves SNF from foreign research reactors. The SNF Program is preparing the "Proposed Policy for Management of U.S.Origin Foreign Research Reactor SNF EIS" to support a decision regarding the implementation of a nuclear nonproliferation policy for acceptance into the United States of FRR spent fuel containing uranium of U.S. origin. (To facilitate discussion, this EIS will be designated the FRR SNF EIS.) This document will evaluate the potential environmental effects of establishing and implementing a policy to manage spent fuel from foreign research reactors over the next 10 to 13 years. The FRR SNF EIS will defer to the Programmatic SNF EIS for siting alternatives but identifies the environmental consequences for a stand-alone, site-specific FRR SNF management approach. The selection of a site or sites to manage FRR SNF would be based on the Programmatic SNF EIS, and no decisions on the proposed policy would be made unti both EISs are completed. The Record of Decision (ROD) for the FRR SNF EIS is scheduled to be issued by December 1995.

The third set of decisions involves the interim management of nuclear materials at specific DOE sites. At SRS, DOE needs to decide what materials can safely rema in their current form for an interim period (approximately 10 years) until disposition decisions can be made. DOE must also decide which materials are at risk and therefore require near-term stabilization to assure continued safe management. DOE will also determine appropriate stabilization methods and decide whether it has a need for certain nuclear materials and, if so, how to convert the materials to a useful form. Accordingly, DOE is preparing an EIS, titled "Interim Management of Nuclear Materials (IMNM) at the Savannah River Site." This document is scheduled for release in final form in May 1995, with an ROD scheduled for July 1995. Subsequent to the RODs for the IMNM EIS and the Programmatic EIS, a SRS SNF Management EIS will be developed for fuels at SRS which are not considered to be at risk.

At Hanford, an EIS for the management of spent nuclear fuel from the K-Basins is being prepared to examine alternative for the removal and stabilization of the fuel in the K-Basins (see section 3.6.2). The Record of Decision is scheduled for December 1995.

Key Challenges

- Proposing a strategy for ultimate disposition of DOE-owned SNF (e.g., the first geologic repository or alternatives).
- Obtaining stakeholder acceptance of planned activities.
- Development and demonstration of the technologies for mitigating corrosion mechanisms of DOE-owned spent fuels, conditioning of hydrided and corroded N-Reactor fuels, and placing of DOE-owned SNF into dry interim storage.

The Office of Spent Fuel Management has been performing complex-wide integration of spent fuel management activities. They will continue to perform this function in the future but will communicate with the Task Group to ensure the coordination of potentially interrelated actions. An example of an action that would require coordination is the stabilization of spent fuel at Savannah River because of its potential impact on stabilization actions for plutonium solutions or special isotope solutions.

The following initiatives are underway to address the key challenges identified:

- The Department of Energy is in the process of developing a proposed strategy for the ultimate disposition of DOE-owned SNF. a draft action memorandum for the Secretary of Energy that articulates a strategy for a proposal for ultimate disposition of DOE-owned spent fuel is undergoing senior management review.
- To improve the involvement of stakeholders, the Office of Spent Fuel Management has developed a Stakeholder Involvement Plan that tiers off the Environmental Management Public Participation Program Plan. Significant

stakeholder involvement actions were a key element of the development o: Programmatic Spent Nuclear Fuel and the Foreign Research Reactor Environmental Impact Statements. Continued efforts are necessary to ensure stakeholder acceptance of future spent fuel management actions.

- R&D efforts are in progress to support the placement of spent nuclear fuel in safe, secure interim storage. The coordination of these efforts is achieved through the Technology Integration Technical Working Group established by the Office of Spent Fuel Management in June 1993. A Technology Integratio Plan was issued in December 1994. The plan's purpose is to establish all the planned and proposed technologies envisioned as necessary to support the spe: nuclear fuel program. Specifically, efforts are underway using the Pacific Northwest Laboratory to support the characterization and stabilization of spen fuel and sludge at the Hanford K-Basins. Efforts to determine the behavior o hydrided N-Reactor fuel will be initiated by April 1995. Other efforts includ the study of spent fuel corrosion mechanisms associated with wet and dry storage and the study of heat transfer mechanisms associated with dry storage

Part III: Individual Site Activity Plans

3.6.2 Hanford Spent Nuclear Fuel

Hanford Facility Description

The K-East and K-West Storage Basins were constructed in the early 1950s to provid temporary storage of Single Pass Reactor fuel discharged from the K Reactors until the K Reactors were shut down in 1970. Subsequently, the basins were used for storage of N Reactor spent fuel. The basins are located approximately 1,000 feet from the Columbia River. They are unlined, concrete, 1.3-million-gallon water pool with an asphaltic membrane beneath each basin. The K-East Basin presently stores approximately 1,152 metric tons of initial heavy metal (MTIHM). The spent fuel ha been stored under water in open-top canisters for periods ranging from 6 to 23 years. The fuel is corroding and an estimated 50 cubic meters of sludge has accumulated in the basin containing radionuclides, corrosion products, and miscellaneous materials. The K-West Basin presently stores approximately 953 MTIHM. Prior to storage in the K-West Basin, the spent fuel was placed in closed canisters and thus there is no appreciable sludge buildup in the basin. Leakage to the environment from K-East Basin has occurred, most likely at the basin discharge chute construction joint. The asphaltic membrane does not extend beneath this area. The K-West Storage Basin is not believed to be leaking. The discharge chute construction joints between the foundations of the Basins and the K-Reactors are not adequately reinforced, and a seismic event could trigger considerable leakage due to displacement.

Hanford Issues

To address the urgent K-Basin issues, the Department and Westinghouse Hanford Company have developed a K-Basins recommended path forward that greatly accelerates fuel removal from the basins, stabilizes it, and places it in safe, secure interim storage. The Department's decision concerning such proposed actions will be based on an anticipated EIS for the K-Basin fuel, as well as the SNF PEIS and ROD. Currently, several near-term actions are being taken to minimize safety and environmental risks for the short time that the fuel remains in storage at the basins. These actions include the installation of cofferdams to isolate the basin water from the suspected leakage site, several dose reduction measures to minimize worker exposure, essential facility services upgrades, conduct of operations improvements, and fuel/sludge characterization.

An EIS for the management of SNF from the K-Basins is being prepared; it will examine alternatives for the removal and stabilization of the fuel from those basins. The discussion that follows is the recommended path forward for this activity. The nature and timing of these implementing actions are contingent upon the ROD, scheduled for December 1995.

The key elements of the K-Basins recommended path forward are described below:

- The first step would place fuel and sludge in wet or damp inerted Multi-Canister Overpacks and transfer the overpacked fuel to a Canister Storage Building (CSB) prior to fuel drying and passivation. This step would remove fuel from the deteriorating safety and environmental conditions at the K-East Basin at the earliest possible date.

- Depending upon decisions in the SNF PEIS, ROD scheduled for June 1995, the second step would transfer the fuel in the Multi-Canister Overpacks to a Conditioning Facility where it would be dried and passivated. The fuel would then be returned to the CSB in dry, inerted Multi-Canister Overpacks for long-term interim storage. This would achieve safe interim storage pending final disposition activities. Using the same Multi-Canister Overpacks for both storage conditions and the conditioning process minimizes the total amount of waste to be generated. Simultaneous initiation and performance of the two steps will enable expeditious implementation of dry interim storage.

This dry storage configuration would result in a stable passive system designed to arrest further fuel corrosion, the fuel remaining in its metallic form protected by an unreactive oxide coating and an inert gas environment. This condition maximizes stability and safety while maintaining the flexibility to further process the SNF into a waste form suitable for disposition if this proves to be necessary. The CSB will be designed and constructed to modern design standards and seismic criteria suitable for the 40-year storage requirement. It would also use a double containment (sealed Multi-Canister Overpack in a storage tube with inspectable seals) and a high-efficiency-particulate-air (HEPA) filtered confinement system.

K-Basins Path Forward Near-Term Objectives

Other activities to improve the near-term safety and environmental posture at the K-Basins include:

- Installation of cofferdams between the basin and the discharge chute to isolate the basin from the suspected leak site located in the unreinforced construction joint in the discharge chute. This action is being taken to minimize the potential for environmental release of contaminated sludge either directly through the leak into the ground or by airborne release, should the basin be drained as a consequence of a seismic event and the sludge dry to a powder. This action also addresses concerns about fuel dryout and possible pyrophoric ignition leading to radioactive material releases. Maintaining the fuel under water prohibits pyrophoric ignitions.

- Performance of fuel and sludge characterization to assess fuel condition, the degree of hydriding, and the makeup of the sludge. The fuel data will be use to support safety analyses for transport of the fuel and development of a fuel conditioning process to eliminate reactivity and pyrophoricity concerns in t stabilized condition. Sludge characterization will be used in determining the path forward for the sludge.

- Development of a path forward for basin sludge that considers the probable differences between sludge in the fuel canisters and sludge lying on the basin floor. While the sludge contained in the fuel canisters is primarily the result of fuel corrosion, the vast majority of the sludge on the basin floor is believed to consist of blow sand, structural material oxides, and concrete spallation products. While the canister sludge could remain with the fuel and be considered SNF, it may be possible to dispose of the basin sludge through existing waste disposal systems.

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

- Completion of essential facility systems recovery actions 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 ba walls and pipe runs.

- Removal of debris from the K-East Basin such as unused canisters and discarded tools. This waste will be cleaned and compacted prior to shipment to the solid waste management area to minimize the waste volume.

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

- Preparations for operational readiness to support fuel removal activities.

<u>K-Basins Recommended Path Forward Schedule</u>

Depending on the alternative selected in the K-Basins EIS Record of Decision and the acquisition strategy, the schedule will be limited by the design, construction, and operational readiness of the new CSB. The K-Basins Path Forward preliminary schedule indicated that fuel and sludge removal from the K-Basins would begin in December 1998 and be completed in November 2000, an acceleration of two years over the previous schedule for fuel encapsulation that supported the Tri-Party Agreement (TPA) target milestone of December 2002. Additional means to accelerate of the K-Basins Path Forward schedule were recently identified such that the Department now plans to begin fuel removal by December 1997 and to have the fuel removed from the K-Basins by December 1999.

Key schedule dates supporting the K-Basins Path Forward between now and December 31, 1995, are:

- Develop potential funding options and an acquisition strategy as appropriate by the end of March 1995.

- Issue Notice of Intent for K-Basins EIS in March 1995.

- Complete cofferdam installation in K-West Basin by February 1995 and in K-East Basin by April 1995. (K-West installation is being performed first to qualify materials, processes, and procedures before installation in the more adverse conditions in K-East Basin.)

- Start fuel characterization in hot cells by April 1995.

- Issue K-Basins EIS Record of Decision by December 1995.

- Initiate sludge retrieval demonstration in conjunction with cofferdam installation by April 1995.

Additional dates will be included in the K-Basins integrated schedule that will be issued by May 1995. This schedule will provide details of major system acquisitions and material movements. The following milestones will be included:

- Complete NEPA process.
- Submit project validation package.
- Initiate development for N Reactor fuel stabilization process.
- Finalize site identification and initiate site characterization for facilities.
- Place contract(s) for necessary equipment and facilities.
- Begin fuel removal from K-Basins.
- Design Multi-Canister Overpack.
- Begin Multi-Canister Overpack manufacture.
- Start and complete construction of Canister Storage Building.
- Start and complete construction of Conditioning Facility.
- Start and complete fuel stabilization.
- K-Basin fuel in dry storage.

Related issues also exist at the PUREX facility where some single-pass reactor fuel is stored in baskets in the receiving basin and some N Reactor fuel lies on dissolver cell floors. These issues are related to the K-Basins issues because of the fuel type. The fuel currently in PUREX is scheduled to be moved to K-East Basin and disposed of a part of the K-Basins Path Forward.

3.6.3 Savannah River Spent Nuclear Fuel

Savannah River Facility Description

K, L, and P Reactor Disassembly Basins: The three Reactor Disassembly Basins are unlined, concrete water pools that have stored of spent fuel, target assemblies, and other radioactive material for up to seven years. The basins have been in operation since 1954 and hold 3.5 to 4.5 million gallons each. The total inventory in the three basins consists of approximately 12,500 Mk31 U-238/Pu-239 targets containing approximately 115 metric tons of heavy metal and approximately 1,870 Mk16 and Mk22 spent fuel elements containing 7.2 metric tons of heavy metal. The extended duration of storage, poor water chemistry control, galvanic coupling, damaged cladding due to handling, and lack of appropriate water filtration systems have all contributed to accelerated corrosion of the spent nuclear fuel and target materials ar 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.

Receiving Basin for Off-Site Fuels: The Receiving Basin for Off-Site Fuels (RBOF) Facility stores reactor fuel elements from off-site reactors and occasionally from on-site reactors. The RBOF is a concrete pool with a volume of approximately 500,000 gallons. Placed into operation in 1963, it has a stainless steel bottom and Phenoline resin-coated walls. The original design incorporated a basin water chemistry control system consisting of a filter and mixed ion-exchange resin deionizer system. The fuel elements in the RBOF, some of which have been in the basin for 30 years, show no visible signs of corrosion. The fuel assemblies, canisters of fuel, and targets, which contain 60.6 metric tons heavy metal, are stored at RBOF in storage racks that provide the spacing required to preclude nuclear criticality. The roof over the cask basin and the transite walls provide inadequate protection to prevent penetration of tornado-generated missiles. RBOF was not designed to meet current seismic standards and the storage racks, although anchored to the floor and walls of the basin, are not seismically qualified.

F- and H-Canyons: The F- and H-Canyons have two dissolvers each that provide the capability to process spent fuel and target material to recover special nuclear material. They include small water basins, with volumes of approximately 4,000 to 12,000 gallons, for spent fuel and target assemblies that are awaiting processing. The facilities have been in operation since the mid-1950s. The basins were not designed for long-term storage. The inventory in F-Canyon is comprised of 2,448 Mk-31A targets containing 22.6 metric tons of heavy metal. The inventory in H-Canyon is comprised of 13 Mk 16/Mk 22 spent fuel assemblies, which contain a total of 68 kilograms of heavy metal. Because the Canyons were not designed and constructed to current seismic standards, a criticality could potentially occur as a result of seismically-induced damage to the H-Canyon fuel storage racks. The Canyons lack means to maintain water chemistry and corrosion of fuel and targets is occurring.

Savannah River Issues

Processing Enriched Uranium in H-Canyon (Baseline Planning Case)

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

Assuming the preferred options are selected in the IMNM EIS ROD, stabilization operations would be similar to traditional operations, outlined above. Based upon this assumed selection, Mk31 target stabilization is expected to begin in F-Area in

November 1995, and stabilization of SRS Mk16 and Mk22 HEU SNF is expected begin by November 1996. The HEU SNF would be dissolved in the H-Canyon consistent with past practice. The resulting enriched uranium solutions would then b transferred to the enriched uranium storage tank in the H-Area A-Line facility for temporary storage. At the same time, depleted uranium oxide currently stored in drums would be dissolved in the F-Area A-Line facility, placed into a transfer truck (equivalent to the HM trailers used for transfer of enriched uranium solutions to Oak Ridge in the past), and transferred to the H-Area A-Line facility. This depleted uranium solution would be mixed with the enriched uranium solution in the enriched uranium storage tank, diluting it to approximately 0.9 at % U-235. The dilution is necessary to control criticality during processing in the F-Area A-Line facility, as it was designed to handle only depleted uranium solutions resulting from processing of Mk31 targets. This newly diluted solution would then be pumped back into the transfer trailer and returned to the F-Area A-Line facility where it would be converte to oxide for storage. Assuming a canyon dissolver capacity of approximately 2,000 elements per dissolver per year, and that F- and H-Canyons have two dissolvers available, the dissolution of Mk31 targets and Mk16 and Mk22 SNF will be completed in September 1996 and November 1999, respectively. When processing is completed, miscellaneous aluminum-clad targets and fuels will be stabilized via dissolution and processing with waste transferred to the Waste Tank Farm. The eventual vitrification of radioactive material will occur in the Defense Waste Processing Facility (DWPF). Sufficient tank volume exists to handle the projected waste steams.

While this processing scenario requires trucking uranium solutions between the F- an H-Areas, no new technology would be required, and the trucking is already planned to occur as part of the disposition of existing H-Canyon uranium solutions. Past processing practices produced enriched uranium solutions for storage in H-Area A-Line, transferred uranium solutions in trailers (enriched solutions to Oak Ridge rather than depleted solutions from F- to H-Areas), and produced depleted uranium oxide in the F-Area A-Line. The only change required to complete the HEU SNF processing using this technique would be the installation of a trailer loading and unloading port i the F-Area A-Line for the transfer of depleted uranium solution and the receipt of isotopically diluted H-Canyon solutions.

In further response to Recommendation 94-1, the Department is exploring possible acceleration of this schedule using various combinations of canyon capabilities.

Savannah River Near-Term Objectives

A recent structural assessment for the K-Reactor Disassembly Basin exterior walls an foundations determined that they could withstand a 0.2 g earthquake, the current DOE design basis seismic criteria. For such an occurrence, minor leakage could occur through an expansion joint or cracks in the retaining walls; however, the leakage would be very slow. The consequences of an earthquake for the L- and P-Reactor Disassembly Basins are less than those for the K-Reactor Disassembly Basin becau the K-Reactor Disassembly Basin has the highest radionuclide inventory. A detailed structural assessment for design basis hazards is being performed for RBOF in order to upgrade the safety analysis reports A seismic assessment of the H-Canyon and its components is also underway as part of the effort to upgrade its safety analysis report.

To reduce the corrosion rate of fuels and storage equipment, the L-Reactor Disassembly Basin will undergo a cleaning and conductivity reduction campaign. Sludge has been vacuumed from approximately 70% of the basin floor and conductivity has been substantially lowered. Additionally, a one-time batch deionization will be conducted; that, along with other upgrades, will maintain conductivity below critical levels. Corrosion surveillance indicates progress in slowing the corrosion rates of aluminum in the basin. Coupons were immersed in the L-Reactor Disassembly Basin in late 1993 and were examined in March 1994 revealing no signs of pitting after 180 days of exposure. These coupons will be reexamined in late February 1995.

Upgrades, necessary to permit extended storage of aluminum-clad SNF in L-Reactor Disassembly Basin, are in progress and funded for implementation. Similar activities are planned for K-Reactor Disassembly Basin, with completion for both areas scheduled for May 1996. These changes are expected to improve the Reactor Disassembly Basins water chemistry to levels approaching RBOF. The upgrades include:

- One-time vendor "shock" deionization of the basin.
- Installation of continuous deionization system sized to treat the basin proper. The existing system was originally designed to treat only basin discharge water.
- Operation of a zeolite deionization system designed to remove Cesium-137.
- Installation of a deionized make-up water system. Current make-up water is filtered well water.
- Additional groundwater monitoring wells.

Additionally, vertically stored fuel in K- and L-Reactor Disassembly Basins will be reoriented to eliminate galvanic coupling and associated storage equipment corrosion.

The current SRS schedule is as follows:

- Complete vacuum consolidation of L-Reactor Disassembly Basin sludge (currently more than 70% complete) by September 1995.
- Reorient fuel in L- and K-Reactor Disassembly Basins to horizontal configuration by February 1996 and February 1997, respectively.

- Begin stabilization of Mk31 target inventory in F-Area in November 1995.
- Complete fuel consolidation to free approximately 1,250 additional storage spaces in RBOF by December 1995.
- Complete K- and L-Reactor Disassembly Basins upgrades by May 1996.
- Complete stabilization via dissolution of Mk31 targets in F-Canyon by September 1996.
- Complete vacuum consolidation of K-Reactor Disassembly Basin sludge in FY 1996.
- Begin processing of Mk16 and Mk22 SNF in November 1996.
- Remove consolidated basin sludge from K- and L-Reactor Disassembly Basins by September 1997.
- Complete dissolution of Mk16 and Mk22 SNF by November 1999 and stabilization of resultant uranium solutions by April 2000.

3.6.4 Idaho Spent Nuclear Fuel

Idaho Facility Description

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

Idaho Issues

A federal court order specifies a schedule for fuel movement from CPP-603. This includes 189 fuel units moved by September 1994, an additional 189 units by December 1995, all fuel moved from the North and Middle basins by December 1996, and all remaining fuel removed by December 2000. The plan first calls for fuel whose cladding is intact to be moved to the CPP-666 wet storage facility in available transport casks. Fuel with suspect cladding integrity will be packaged in dry overpacking station in the CPP-603 Irradiated Fuel Storage Facility (IFSF) fuel handling cave for safe transfer and short-term interim storage. Following the overpacking, this fuel will be stored in the CPP-666 underwater fuel storage area unless an agreement with the State of Idaho can be reached to store it in appropriate dry storage areas. To date, the first 189 fuel units were expedited to complete movement by July 1994, and 10 additional units were removed by September 1994. Means are being pursued to expedite removal of the spent nuclear fuel from the CPP-603 basin in advance of the date specified in the court order, December 2000.

Installation of accurate level-monitoring instrumentation for the basin water and an accurate basin water balance program will partially compensate for the absence of leak detection systems. Several actions have been completed to improve criticality safety, including storage yoke rerigging, repackaging of some corroded canister, and fuel spacing. The EBR-II uranium metal fuels, which also contain metallic sodium for bonding, are canned because they are potentially reactive with water. Complete underwater video inspections of all spent fuel and storage equipment have been completed. Canisters will be nondestructively examined to determine the condition of the canisters and their contained fuel. Corrective actions taken to address corrosion include storage yoke rerigging, fuel repackaging, and full implementation of a corrosion monitoring program. Moreover, ion exchange resin replacement/regeneration has significantly reduced radioactivity levels in the basin water and improved overall basin water chemistry. Recently completed structural analyses have determined that the storage basins will meet the design basis seismic events. A system analysis found that only two of the noncompliances concerning the steel superstructure warranted correction. Corrective actions are in progress.

The key milestones for accomplishing removal of CPP-603 from service are provided below.

- Establishment of the Facility Safety Authorization Basis — Currently complete (included rerigging, of storage equipment, SNAP fuel recanning, video inspection of all spent fuel and storage equipment, and seismic evaluation).
- Movement of first 189 units from North and Middle Basins to CPP-666 — Completed in July 1994. Moved 10 additional units in September 1994.
- Movement of South Basin Fuels — Begin by July 1995.
- Movement of second 189 units from North and Middle Basins to CPP-666 by December 1995.
- Removal of all fuel from the North and Middle Basins by December 1996.
- Removal of all fuel not requiring overpacking by December 1998.
- Dry Storage Overpacking Station construction and startup by December 1998.

- Fuel Removal from the CPP-603 South Basin by December 2000.

An INEL Spent Nuclear Fuel Management Plan is currently under development to direct the placement of spent fuel currently in existing INEL facilities into interim storage. The plan will also address the coordination of intrasite fuel movements wit new fuel receipts and intersite transfers that may be required in accordance with the upcoming DOE SNF Programmatic EIS ROD. The plan assumes that all spent fuel INEL will be placed into dry storage facilities or shipped offsite until it can be prepared for final disposition. The CPP-666 underwater storage facility will be maintained to provide temporary storage for spent fuel requiring decay cooling befo it can be moved to dry storage.

3.6.5 Key Milestones

<u>SNF Program Activities</u>

Phase III Plan of Action Issued	October 19
Strategic Plan Issued	December 19
Programmatic SNF EIS Record of Decision	June 19
Environmental Management Programmatic EIS Record of Decision	September 19
SNF Program Plan	November 19
Foreign Research Reactor EIS Record of Decision	December
Repository EIS Record of Decision	September 2

<u>Hanford Milestones</u>

Notice of Intent for K-Basins EIS	March 19
Fuel Characterization Begin	April 199
Integrated Path Forward Schedule	May 199
K-Basins EIS Record of Decision	December 199
Fuel Removal Begin	December 199
Fuel Removal Complete	December 199

<u>Savannah River Milestones</u>

Interim Nuclear Materials Management EIS Record of Decision	July 199
Processing of Mk31 Targets in F-Canyon Begin	November 199
RBOF Fuel Consolidations	December 199
K- and L-Basin Upgrades	May 199
Processing of Mk31 Targets in F-Canyon	September 199
Dissolution Mk16/Mk22 Spent Fuel Begin	November 199
Dissolution of Mk16/Mk22 Spent Fuel	November 199
Stabilization of resultant uranium solutions	April 200

Idaho Milestones

189 Fuel Units from North/Middle Basins Removed	July 1994
Removal of next 189 Fuel Units from North/Middle Basins	December 1995
Removal of All Fuel from North/Middle Basins	December 1996
Removal of All Fuel Not Requiring Overpacking	December 1998
Startup of Dry Storage Overpacking Station	December 1998
Removal of All Fuel from CPP-603	December 2000

APPENDI

LIST OF ACRONYMS AND ABBREVIATIONS

at %	Atom Percent
ACB	Auxiliary Charcoal Bed
ACRR	Annular Core Research Reactor
Al	Aluminum
ALARA	As Low As Reasonably Achievable
ANL	Argonne National Laboratory
Am	Americium
Am-Cm	Americium-Curium
ARF	Actinide Repackaging Facility
ATLAS	Advanced Testing Line for Actinide Separation
Be	Beryllium
BNL	Brookhaven National Laboratory
C	Celsius (degrees)
Cf	Californium
Co	Cobalt
Cm	Curium
CMR	Chemical and Metallurgical Research [Building] (at Los Alamos)
CPP	Chemical Processing Plant (at Idaho)
Cs	Cesium
CSB	Canister Storage Building (at Hanford)
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DOE/HQ	DOE Headquarters
DOT	Department of Transportation
DP	Defense Programs
DWPF	Defense Waste Processing Facility (at Savannah River)
EA	Environmental Assessment
EBR-II	Experimental Breeder Reactor II
EIS	Environmental Impact Statement
EM	(DOE Office of) Environmental Management
EM-60	Office of Facility Transition and Management
ES&H	Environment, Safety and Health
EU	Enriched Uranium
F	Fahrenheit (degrees)
F_2	Flourine Gas
FFTF	Fast-Flux Text Facility
FMF	Fuel Manufacturing Facility
FONSI	Finding of No Significant Impact
FRR	Foreign Research Reactor

FSF	Fuel Storage Facility
FY	Fiscal Year
g	Gram
HCF	Hot Cell Facility
HCL	Hydrochloric acid
HEPA	High-efficiency Particulate Air
HEU	Highly Enriched Uranium
HEUN	Highly Enriched Uranyl Nitrate
IAEA	International Atomic Energy Agency
IDC	Item Description Code
IFSF	Irradiated Fuel Storage Facility (at Idaho)
IMNM	Interim Management of Nuclear Materials
INEL	Idaho National Engineering Laboratory
IPP	Integrated Program Plan
ISMP	Integrated Stabilization Management Plan
IWG	Integration Working Group
kg	Kilograms
LANL	Los Alamos National Laboratory
LEU	Low Enriched Uranium
LLNL	Lawrence Livermore National Laboratory
MD	Office of Material Disposition
MgO	Magnesium oxide
MIP	Material Integration Plan
MOA	Memorandum of Agreement
MPC	Multi-purpose Canisters
MPPF	Multi-Purpose Processing Facility
MSRE	Molten Salt Reactor Experiment (at Oak Ridge)
MT	Metric Ton
MTIHM	Metric Ton of Initial Heavy Metal
NASA	National Aeronautics and Space Administration
NDA	Non-destructive Analysis (or assay)
NDE	Non-destructive-Evaluation
NE	DOE Office of Nuclear Energy
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NFS	Nuclear Fuel Services, Inc.
NMSF	Nuclear Material Storage Facility
NMSTG	Nuclear Materials Stabilization Task Group
Ni	Nickel
Np	Neptunium
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OAK	(DOE) Oakland Operations Office
OCRWM	Office of Civilian Radioactive Waste Management
ORNL	Oak Ridge National Laboratory
ORO	(DOE) Oak Ridge Operations Office

ORR	Operational Readiness Review
PEIS	Programmatic Environmental Impact Statement
PFP	Plutonium Finishing Plant (at Harford)
PNL	Pacific Northwest Laboratory
PO	DOE Policy Office
Pu	Plutonium
PUREX	Plutonium and Uranium Extraction Process
R&D	Research and Development
R&TD	Research and Technology Development
RBOF	Receiving Basin for Offside Fuels
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
S&M	Surveillance and Maintenance
SARP	Safety Analysis Report for Packaging
SIPP	Site Integrated Program Plan
SISMP	Site Integrated Stabilization Management Plan
SNF	Spent Nuclear Fuel
SNL	Sandia National Laboratories
SNM	Special Nuclear Material
Sr	Strontium
SRS	Savannah River Site
SRTC	Savannah River Technology Center
SS&C	Sand, Slag, and Crucible
SST	Safe, Secure Transport
STD	Standard
TBD	To be determined
TPA	Tri-Party Agreement
TREAT	Transient Reactor Test facility (at Idaho)
TRU	Transuranic
U	Uranium
U_3O_8, UO_3	Uranium Oxide
UF_6	Uranium Hexafluoride
WHC	Westinghouse Hanford Company
WIPP	Waste Isolation Pilot Plant
wt %	Weight percent
ZPPR	Zero Power Physics Reactor

APPENDIX B

GLOSSARY

Actinide - Any element in a series of elements of increasing atomic numbers beginning with actinium (89) or thorium (90) and ending with element of atomic number 103.

Canning - The process of placing spent nuclear fuel in canisters to retard corrosion, contain radioactive releases, or control geometry.

Covered materials - Bulk liquids and solids containing fissile materials and other radioactive substances in spent fuel storage pools, reactor basins, reprocessing canyons, processing lines and various other facilities which require treatment for conversion to forms or conditions more suitable for safe interim storage. Wastes in a recognized treatment system and low-level wastes, most uranium and uranium compounds and weapons usable plutonium already suitable for safe interim storage are not included.

End state: The goal for packaged physical form of a nuclear material at the conclusion of the stabilization project.

Facility condition vulnerabilities - Potential for failures of physical barriers such as equipment, buildings, or safety systems; and holdup of plutonium in a facility.

Gloveboxes - Filtered and ventilated enclosures that allow handling of hazardous materials without direct worker contact with the material.

Institutional vulnerabilities - An administrative or management weaknesses that are underlying causes or significant contributors to material/packaging and facility condition vulnerabilities.

Interim storage - Acquisition, management, and operatation of storage facilities in compliance with approved safety basis pending preparation for final disposition. Long-term interim storage could last for up to 40 years.

Material/packaging vulnerabilities - Potential for releases related to design deficiencies and degradation of materials and packaging due to corrosion, radiolytic damage, or changes in material form.

Passivation - The process of making metals inactive or less reactive. For example, to passivate the surface of steel by chemical treatment.

Processing - Changing the chemical or physical characteristics of nuclear material and/or their packaging configurations.

Processing (of spent nuclear fuel) - Applying a chemical or physical process designed to alter the characteristic of the spent nuclear fuel matrix.

Proximity to Plastic - Where direct communication between the plutonium and the plasti possible.

Pyrophoric - The capability for spontaneous ignition in air at or below room temperature i the absence of added heat, shock, or friction.

Radiolysis - Chemical decomposition by the action of radiation.

Residues - Scrap and compounds generated in the processing, fabrication, or recycling of nuclear materials (particularly plutonium).

Safe interim storage - A safe, controlled, inspectable storage under conditions where minimum surveillance and maintenance is required for the period (potentially decades) prior to ultimate long-term storage and/or disposition. This is the "end state" for purposes of the Integrated Program Plan.

Skulls - Low-density residues from plutonium metal casting operations that have a high surface area, making them pyrophoric.

Spent nuclear fuel - Fuel or targets containing uranium, plutonium, or thorium withdrawn from a nuclear reactor or other neutron irradiation facility following irradiation, the constituent elements of which have not been separated by chemical reprocessing.

Stabilization (of spent nuclear fuel) - Actions taken to further confine or reduce the hazard associated with spent nuclear fuel, as necessary for safe management and environmentally responsible storage for extended periods of time. Activities which may be necessary to stabilize spent nuclear fuel include canning, processing, and passivation.

Task Group - The Nuclear Materials Stabilization Task Group responsible for ensuring the Department achieves commitments detailed in Implementation Plan.

Thermal stabilization - A process of converting potentially reactive plutonium into a stable form which is more safe for storage and transportation.

Transuranic materials - Elements having atomic numbers greater than that of uranium.

Working Group - the Plutonium Working Group, made up of over 150 DOE staff, site contractors, consultants, and stakeholders, who planned and directed the plutonium vulnerability assessment.