Department of Energy
Washington, DC 20585

APR 19 2001

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Ave., NW
Washington, DC 20004

Dear Mr. Chairman:

When the "Strategy for Utilization of the Chemical Processing Canyons at the Savannah River Site" was approved in July 1997, the Defense Nuclear Facilities Safety Board (DNFSB) requested that a complex-wide review of materials potentially requiring canyon processing be completed before a final decision was made on canyon deactivation. The SRS canyons have unique capabilities, and the Department of Energy (Department) also believes it is essential to have a full understanding of its surplus material inventories and corresponding disposition plans prior to termination of canyon capabilities.

The enclosed *Savannah River Site Canyons Nuclear Material Identification Study*, responding to the DNFSB request, presents the results of over three years of extensive analyses. Examples of specific efforts include the Processing Needs Assessment, the Nuclear Materials Integration Project, and Westinghouse Savannah River Company analyses conducted in 1999 and 2000. The objective of these efforts was to identify and review all remaining surplus nuclear materials to determine which materials potentially require utilization of the canyons.

As a result of these analyses, the Department has reached the following conclusions:

- The Department has an excellent understanding of its inventory of nuclear materials and spent nuclear fuel.

- Some of the Department's surplus nuclear materials and spent nuclear fuel do not have defined disposition pathways or have pathways with significant uncertainties.

- Based on in-depth reviews of these materials, the Department is confident that it has identified essentially all those potentially requiring canyon processing.

- A small fraction of the canyon-potential materials may actually require canyon processing.

- None of these materials requires the use of the F-Canyon PUREX process.

In the next few months, the Department will complete analyses of those few material categories for which canyon processing might be needed, e.g., off specification highly enriched uranium. In the longer term, we will also resolve the disposition paths for the limited amount of nuclear materials that have an undecided pathway and monitor to resolution each material category with uncertainties in its established baseline. As noted above, none of these materials requires the use of the F-Canyon PUREX process.

This Nuclear Materials Identification Study supports the *Department of Energy Plan for the Transfer of All Long-Term Chemical Separation Activities at the Savannah River Site from the F-Canyon Facility to the H-Canyon Facility Commencing in Fiscal Year 2002*, which was submitted to Congress on April 10, 2001. Also, the Department is currently evaluating the impacts associated with the use of H-Canyon for additional missions as well as the impacts of H-Canyon remaining operational as a backup capability. If the impacts on H-Canyon are significant, i.e., would require several additional years of operation, the Department could consider limited use of F-Canyon for certain materials if it is more cost effective.

The Department recently decided to delay the Plutonium Immobilization Plant and initiated a feasibility study to determine the possibility of using some of the facilities in the F-Area to perform parts of the fissile materials disposition mission. Specifically, we are studying the possibility of using the "built, but not used" Plutonium Storage Facility and New Special Recovery line in conjunction with other existing facilities in the F-Area. We expect preliminary results later this year and will keep you and your staff informed.

Finally, I would like to express my appreciation for the review comments received from Mr. Michael Merritt of your staff. If you have any questions, please contact me at (202) 586-5151.

Sincerely,

David G. Huizenga
Deputy Assistant Secretary
for Integration and Disposition
Office of Environmental Management

Enclosure
cc:
R. J. Schepens, DOE-SR

U.S. Department of Energy
Office of Environmental Management

Privacy and Security Notices

... managing the legacy of contamination from the nuclear weapons complex

Savannah River Site Canyons Nuclear Material Identification Study

February 2001

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ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

ANL-W	Argonne National Laboratory-West
ASTM	American Society for Testing and Materials
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOE-HQ	DOE Headquarters
DOE-SR	DOE-Savannah River Operations Office
EBR	Experimental Breeder Reactor
EM	Office of Environmental Management
EMT	Electrometallurgical Treatment
FRR/DRR	Foreign Research Reactor/Domestic Research Reactor
INEEL	Idaho National Engineering and Environmental Laboratory
LAMPRE	Los Alamos Molten Plutonium Reactor Experiment
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
MOX	Mixed Oxide
MPPF	Multi-Purpose Processing Facility (at SRS F Canyon)
NEPA	National Environmental Policy Act
NFS	Nuclear Fuel Services
NMI	Nuclear Materials Integration
NMIA	Nuclear Materials Inventory Assessment
NMMSS	Nuclear Materials Management and Safeguards System
NN	DOE Office of Nonproliferation and National Security
NN-60	Office of Fissile Materials Disposition (within NN)
NSNFP	National Spent Nuclear Fuel Program
OR	Oak Ridge Operations Office
ORNL	Oak Ridge National Laboratory
PCS	Phased Canyon Strategy
PFP	Plutonium Finishing Plant (at Hanford)
PIP	Plutonium Immobilization Plant
PNA	Processing Needs Assessment
PNNL	Pacific Northwest National Laboratory
PUREX	Plutonium-Uranium Extraction Process
RBOF	Receiving Basin for Offsite Fuels (at Savannah River Site)
REDC	Radiochemical Engineering Development Center
RFETS	Rocky Flats Environmental Technology Site
RFP	Request for Proposals
RL	Richland Operations Office
ROD	Record of Decision
RW	DOE Office of Civilian Radioactive Waste Management
SNF	Spent Nuclear Fuel
SNM	Special Nuclear Material

SO	DOE Office of Security and Emergency Operations
SRS	Savannah River Site
SS&C	Sand, slag and crucibles
TRU	Transuranic
TVA	Tennessee Valley Authority
UOS	Unallocated off-specification
WIPP	Waste Isolation Pilot Plant
WSRC	Westinghouse Savannah River Company
Y-12	Y-12 Plant (at Oak Ridge)
ZPR	Zero Power Reactor

Chemicals and Units of Measure

Am	americium
Cs/Sr	cesium/strontium
DU	depleted uranium
EU	enriched uranium
HEU	highly enriched uranium
Kg	kilogram(s)
MT	metric ton(s)
MTHM	metric tons of heavy metal
Na	sodium
Np	neptunium
Pu	plutonium
U	uranium
wt.%	weight percent
Zr	zirconium

EXECUTIVE SUMMARY

The Savannah River Site (SRS) chemical separation facilities (F and H Canyon facilities) are the last operable large-scale nuclear material processing facilities in the Department of Energy (DOE) complex. While they are no longer performing their historical missions of recovering uranium and plutonium (primarily for reuse in nuclear weapons programs), they have been operating since 1995 to reduce health and safety vulnerabilities associated with materials that were in forms, or stored under conditions, not suitable for safe long-term storage. The chemical separation activities for currently identified canyon missions in the F Canyon Plutonium Uranium Extraction (PUREX) process are scheduled to be completed by the end of Fiscal Year 2002 and in H Canyon in 2008.

Because some nuclear materials still have unknown or uncertain disposition plans, DOE wants to ensure that it does not shut down the SRS canyons prematurely. However, it would not be cost-effective to maintain their operability indefinitely. To better integrate nuclear material disposition planning and planning for the closure of the SRS canyons, DOE has prepared this Study. This Study presents the results of over three years of analyses (completed between 1997 and 2000) to identify and review all remaining nuclear materials in the DOE complex to determine those that could potentially require utilization of the canyons. Examples of specific efforts to identify these materials are the Processing Needs Assessment, the Nuclear Materials Integration Project, and Westinghouse Savannah River Company (WSRC) analyses conducted in 1999 and 2000. The objectives of these reviews were the following:

1. Develop a comprehensive inventory and understanding of all of DOE's surplus nuclear materials;
2. Determine which of these materials could be processed in the canyons;
3. Assess the disposition plans for these materials to identify which materials could potentially use canyon processing because their disposition pathways were unknown or uncertain; and
4. Determine whether these remaining materials could be processed in H Canyon, if processing in F Canyon PUREX were to be discontinued.

From the material reviews, DOE identified 29 material categories that were compatible with canyon processing and for which the canyons were considered a potential alternative (see table below). Of the 29 material categories, 22 categories have expected or established disposition baselines that do not require canyon processing. The remaining seven material categories (Categories 1-7 in table) are still under active review, and it is too soon to rule out canyon processing as the baseline disposition pathway.

The nuclear materials inventory reviews included use of the DOE Material Control and Accountability system, in addition to specific data from the Plutonium Disposition Program, Highly Enriched Uranium Program, the National Spent Nuclear Fuel Program, the annual DOE Nuclear Material Inventory Assessment, and data input from every DOE nuclear material site. After the scope of known materials was established, reviews were conducted on planned or established baselines for each nuclear material. Since this effort involved several individual reviews over a period of many months, emphasis was placed on keeping current both the disposition path technology and progress toward implementation. In cases where nuclear materials did not have a disposition path established, a review was conducted to determine the extent to which canyon processing would be a potential disposition path. This rigorous process yielded the following groupings of materials:

- **Materials With Pathways Under Active Review;**
- **Materials With Non-Canyon Pathways With Significant Remaining Uncertainty;**
- **Materials With Established Non-Canyon Baselines With A Moderate Probability Of Success; and**
- **Materials With Established Non-Canyon Baselines No Longer Requiring Canyon Backup.**

Below is the current classification of canyon-potential materials by the four material groupings.

Current Classification of Canyon-Potential Materials

Materials With Pathways Under Active Review

1. Off-specification highly enriched uranium (HEU) contaminated with actinides
2. Off-specification HEU contaminated with plutonium (Pu)
3. Off-specification HEU parts contaminated with Pu
4. Off-specification enriched uranium (EU) contaminated with Pu
5. Additional off-specification HEU parts contaminated with Pu
6. HEU/Pu composites at Rocky Flats Environmental Technology Site (RFETS)
7. SRS Mark 18A targets

Materials With Non-Canyon Pathways With Significant Remaining Uncertainty

1. Pu-239 scrap, samples, and standards
2. Transuranic scrap, samples, and standards
3. Europium control elements
4. Lightly or unirradiated reactor fuel
5. Los Alamos Molten Plutonium Reactor Experiment (LAMPRE) fuel

Materials With Established Baselines With a Moderate Probability of Success

1. Hanford high-assay sand, slag and crucibles (SS&C)/fluorides/aluminum alloys
2. RFETS SS&C/fluorides
3. Hanford/Los Alamos National Laboratory (LANL) low-assay SS&C
4. SRS and Oak Ridge off-specification HEU alloy (Type II ingots)
5. Off-specification HEU metal at Oak Ridge (Type III)
6. Cesium/strontium (Cs/Sr) capsules
7. Low-grade Pu oxides (20-30%)
8. Pu residues (10-20%)
9. Uranium-233
10. Foreign and domestic research reactor spent nuclear fuel

Materials With Established Non-Canyon Baselines No Longer Requiring Canyon Backup

1. High-purity Pu metals/oxides
2. Hanford uranium core N Reactor fuel
3. RFETS depleted uranium (DU) and DU/Pu
4. Neptunium-237/plutonium-238 (Np-237/Pu-238) production mission
5. Portsmouth oxide
6. Nuclear Fuel Services (NFS) off-specification HEU
7. Irradiated, sodium-bonded spent nuclear fuel

This Study, the Savannah River Site Canyons Nuclear Material Identification Study, presents the results of over three years of examining nuclear material inventories, their disposition paths, and their potential need for canyon processing. This examination was conducted by subject matter experts from across the DOE complex and was co-led by the Office of Environmental Management (EM) and the Savannah River Operations Office.

From this Study, DOE reaches the following conclusions:

1. DOE has an excellent understanding of its inventory of nuclear materials and spent nuclear fuel.

2. Some of DOE's surplus nuclear materials and spent nuclear fuel do not have defined disposition pathways or have pathways with significant uncertainties.

3. Based on in-depth reviews of these materials, DOE is confident that it has identified essentially all those potentially requiring canyon processing.

4. A small fraction of the canyon-potential materials may actually require canyon processing.

5. None of these materials requires the use of the F Canyon PUREX process.

Therefore, DOE is proceeding with the following actions:

EM's Office of Integration and Disposition, in partnership with DOE Program Offices and Sites, will continue to work aggressively to establish, on a priority basis, baseline disposition paths for materials with undecided disposition paths. Also, the Department will complete specific actions to address the following few remaining materials that are under active review:

- Off-specification HEU contaminated with actinides
- Off-specification HEU contaminated with Pu
- Off-specification HEU parts contaminated with Pu
- Off-specification EU contaminated with Pu
- Additional off-specification EU parts contaminated with Pu
- HEU/Pu composites
- Mark 18A targets at SRS

DOE will complete the reviews of these materials and canyon evaluations by June 2001. This will allow DOE to then develop long-term plans for the F Canyon facility. Further, DOE will continue to monitor canyon-potential materials with established baseline disposition pathways to confirm that outstanding uncertainties can be resolved within the scheduled period of operation for H Canyon.

I. INTRODUCTION

Since 1995, the U.S. Department of Energy (DOE) has been eliminating health and safety vulnerabilities through processing of materials in the F and H Canyons at the Savannah River Site (SRS). Materials are being processed either because of the urgency of the potential risks or the lack of an alternative means to stabilize or prepare them for final disposition, i.e., disposal or reuse. Because DOE has recognized that the canyons cannot cost-effectively be maintained indefinitely, there have been several activities over the last three years to inventory DOE's universe of nuclear materials (and spent nuclear fuel), identify which materials would be compatible with canyon processing, and evaluate the feasibility of their disposition paths. DOE has also been successful in establishing non-canyon disposition paths for several materials that had been previously proposed for canyon processing. Examples of this progress include:

- A decision to use the melt and dilute technology for aluminum-clad spent fuel;
- A decision to use electrometallurgical technology for sodium-bonded fuel;
- A decision to package N Reactor fuel in multi-canister overpacks and pursue direct disposal in a geologic repository;
- A decision to dispose in the Waste Isolation Pilot Plant (WIPP) the low-assay plutonium residues currently stored at the Rocky Flats Environmental Technology Site (RFETS);
- A decision to dispose of surplus plutonium via immobilization or mixed oxide fuel;
- Decisions to utilize commercial processing for certain quantities of surplus uranium; and
- A decision to issue a Request for Proposals (RFP) to explore commercial interest in extraction of medical isotopes and preparation of U-233 materials for storage until disposal.

This Study describes the process used to identify and analyze any remaining nuclear materials, beyond the currently identified canyon missions, that could impact future canyon operations, the scope of materials and results of the analyses, and the recommended path forward.

II. BACKGROUND

The SRS chemical separation facilities (F and H Canyon facilities) are the last operable large-scale nuclear material processing facilities in the DOE complex. The canyon facilities, each having unique but complementary capabilities, were designed to separate, purify, and solidify large quantities of nuclear materials for the nuclear weapons program and civilian applications.

In 1992, then Secretary of Energy Watkins issued a decision to phase out canyon processing for the production of weapons materials. With the canyons no longer operating, a number of nuclear materials at SRS and other sites were essentially left in the processing pipeline. This posed potential health, safety, or environmental vulnerabilities because they were in forms, or stored under conditions, not suitable for safe long-term storage. These materials were identified by the Department in complex-wide vulnerability studies and also by the Defense Nuclear Facilities Safety Board (DNFSB) in its Recommendation 94-1 to the Department.

The Department's February 28, 1995, Implementation Plan in response to DNFSB's Recommendation 94-1 was based on operation of both F and H Canyons in order to stabilize the "at risk" materials identified by DOE and the DNFSB. After completion of appropriate National Environmental Policy Act (NEPA) review, the F Canyon facilities resumed operating in 1995 in order to stabilize the "at risk" materials to address the potential health, safety, and environmental vulnerabilities. The H Canyon remained inoperative during this time.

On July 17, 1997, then Secretary of Energy Federico Peña approved the Strategy for Utilization of the Chemical Processing Canyons at the Savannah River Site [referred to as the "Phased Canyon Strategy" (PCS)] for transmittal to Congress pursuant to Section 3142 of the National Defense Authorization Act for Fiscal Year 1997 (Public Law 104-201). The PCS provided for the earliest stabilization of SRS materials deemed to be a health, safety or environmental risk and stabilization of selected offsite materials (primarily from the Rocky Flats Environmental Technology Site) as determined by the completion of NEPA analyses. Approval of the PCS also allowed for the phased restart of H Canyon, which began in 1997. Other DOE decisions since 1997 have resulted in materials either being added to or subtracted from the SRS canyons' missions (see Appendix 1). Today, current canyon planning scenarios show that F Canyon PUREX will complete chemical separation activities in Fiscal Year 2002, while the H Canyon is scheduled to operate into Fiscal Year 2008. Further details on the canyon facilities schedules are shown in Figure 1.

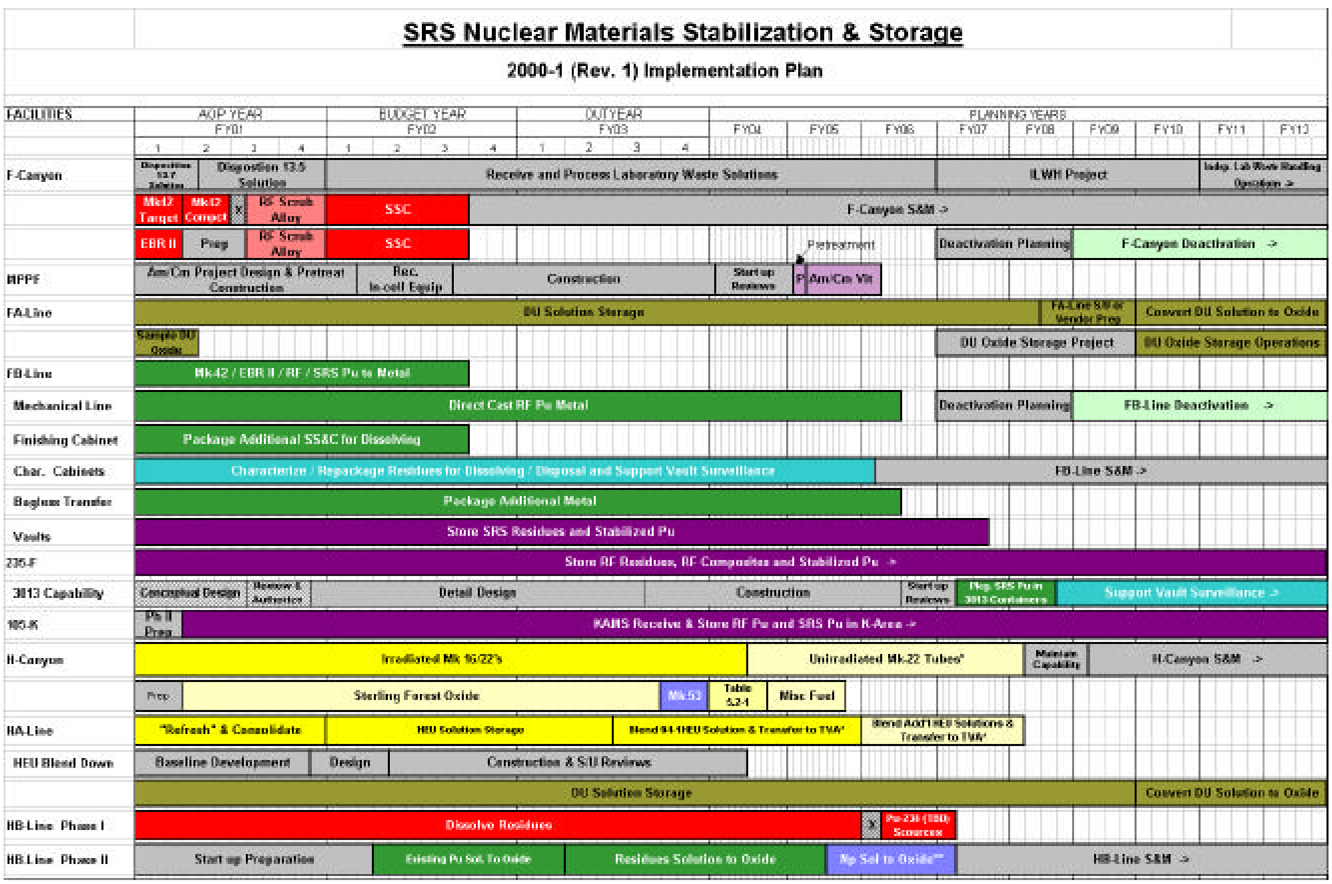


Figure 1

"The Defense Nuclear Facilities Safety Board supports the strategy in the near-term, but requested that the complex-wide review of materials potentially requiring canyon processing … be completed before a final decision is made on deactivation of the canyons".

Since the focus of the PCS was primarily on materials at the SRS, the DNFSB requested that a complex-wide review of materials potentially requiring canyon processing be completed before a final decision is made on deactivation of the canyons. The Department agreed to the DNFSB request and has engaged in extensive activities since the 1997 approval of the PCS to address the request. This Study describes the scope and results of these activities.

III. CANYON-POTENTIAL MATERIALS IDENTIFICATION

In the almost four years since approval of the PCS, a number of assessments, reviews and analyses have been conducted to ensure that all materials that may potentially require canyon processing have been identified and to ensure that plans to stabilize and/or disposition these materials are established. Because of the unique capabilities of the canyon facilities, it is essential that the Department understand its material inventory and the plans for the materials so that canyon capabilities are not shut down or lost prematurely.

Actions to Identify Canyon-Potential Materials

- Complex-Wide Data Calls
- Processing Needs Assessment
- Canyon Potentials Analyses
- Nuclear Materials Integration Project
- Site Visits
- Implementation Plans for 94-1/00-1
- Nuclear Materials Stewardship Initiative
- Savannah River Site Canyons Nuclear Material Identification Study

A. Major Activities to Identify Canyon-Potential Materials

After the Secretary's approval of the PCS in July 1997, DOE undertook several major activities to identify canyon-potential materials. Each activity evolved from (and built upon) the previous activity, culminating in results and conclusions contained in this Study. The major activities are summarized below (in the chronological order in which they occurred). The remaining sections describe the process used during these efforts to identify canyon-potential materials and the analysis of the probability that the canyons may be needed.

1. Processing Needs Assessment

In August 1997, the Department chartered the Nuclear Materials Processing Needs Assessment (PNA). The assessment was identified as a task to be accomplished as part of the Secretarial approval of the PCS in July 1997. The purpose of the assessment was to determine which, if any, additional nuclear materials within the DOE complex may require use of the SRS canyon facilities for stabilization or preparation for disposition prior to canyon decommissioning. The PNA evaluated four material categories (spent nuclear fuel, plutonium-239, uranium, and special isotopes) for possible processing in the SRS F and H Canyon facilities. When the Assessment Team completed its review in February 1998, it identified a limited number of materials that should be considered for canyon processing (a listing of these materials is provided in Appendix 2). In addition, the Assessment Team identified a number of technical and programmatic issues and uncertainties with the baseline disposition plans of several other materials and recommended that canyon processing should be considered a backup should the primary approach fail.

2. Nuclear Materials Integration Project

The Nuclear Materials Integration Project (NMI) was chartered, in part, to identify the Department's surplus nuclear material inventories and to provide life-cycle disposition plans for these materials. Thus, although identification of canyon-potential materials was not a direct objective of this project, the project provided significant insight into the Department's inventory and allowed greater confidence that all canyon-potential materials had been identified.

NMI project personnel collected and collated numerous site-specific and material-specific DOE databases to assemble the most comprehensive and consolidated information on DOE's nuclear materials. Primary sources of this information included the Nuclear Materials Inventory Assessment (NMIA), the Processing Needs Assessment (described above), individual contacts with universities and commercial businesses, and site visits. This information was captured in databases and a disposition mapping system, which now permits the more exhaustive and exacting manipulation necessary to support surplus nuclear materials management. Efforts to improve the inventory information continue. This system, which is tied to the Office of Environmental Management's (EM) Integrated Planning, Budgeting and Accounting System, has provided insight into the number and types of surplus nuclear material streams throughout the complex, including those that have undecided disposition paths. The system continues to be used to monitor and assess disposition planning and implementation.

3. Canyon-Potentials Analyses

In 1999, the Savannah River Operations Office (DOE-SR) requested the Westinghouse Savannah River Company (WSRC) to develop an analysis of DOE nuclear materials that were recently identified as "potentially" requiring SRS canyon processing. This original analysis concluded that 23 specific categories of materials could potentially require canyon processing, some being more likely than others. Also, to ensure that this effort did not miss any of the materials identified in the PNA, a crosswalk mapping was performed between the WSRC canyon-potential analysis and the PNA. In 2000, additional analysis was done to further assess the likelihood of the materials' need for canyon processing.

In general, the objectives of all of the above activities were as follows:

1. Develop a comprehensive inventory and understanding of all of DOE's surplus nuclear materials;
2. Determine which of these materials could be processed in the canyons;
3. Assess the disposition plans for these materials to identify which materials could potentially use canyon processing because their disposition pathways were unknown or uncertain; and

4. Determine whether these remaining materials could be processed in H Canyon, if processing in F Canyon PUREX were to be discontinued.

The approach taken to accomplish these objectives and the results are described in Section B.

B. Identification of Canyon-Potential Materials

This section examines in more detail the scope of materials that have been considered for canyon processing, the process that was used to determine the likelihood of requiring canyon processing, and the results from the major activities described in Section A, above.

1. Identification of Canyon-Potential Materials – Scope and Process

The first objective in addressing what materials may require canyon processing was to develop a comprehensive understanding of all of DOE's major holdings of nuclear materials. Essentially, a material balance was done utilizing DOE nuclear materials accountability systems. Identification of the total inventory of materials has been a significant task in that the Department currently manages its nuclear materials under eight programs that have activities in 36 different locations. Therefore, gathering and developing this information has engaged many Headquarters, field, contractor, and laboratory personnel across the complex.

The next step in the process involved screening out the material that was currently under active use and would remain under active use for the foreseeable future. Active use materials primarily include those maintained for defense related purposes and are referred to as national security materials. The rest of the DOE nuclear material inventory is considered excess to national security, however, there still may be a non-defense related programmatic use for some of it. If there is no programmatic use for a material, it is considered surplus. The surplus inventory was the focus of the canyon-potential material identification process.

Next, a determination was made as to which surplus materials were compatible with canyon processing. Some consideration was given to canyon modifications that could permit canyon processing of the materials, such as decladding or shear and leach operations or a change in process piping or flowsheets. If materials were compatible with canyon processing by these or other means, they were also classified as canyon-potential materials. If materials did not meet basic requirements for canyon compatibility, they were removed from further consideration. Some examples of materials that were determined not to be canyon compatible included:

- Certain clad (zirconium, stainless steel) fuels
- Uranium/zirconium alloy fuels (Naval Reactors)
- Plutonium with high chloride content
- Difficult-to-process plutonium residues (high-fired ash, etc.)

As mentioned before, materials that are considered as active or programmatic use were not addressed in the analyses. However, the types of materials that have been declared surplus and have been addressed as potentially requiring canyon processing are representative of these materials. Therefore, it can be concluded that if additional materials of a like nature are declared surplus in the future, then they could be processed in a similar manner. The following paragraphs (and Figure 2) elaborate further on the scope and process. As described earlier, a number of activities have been undertaken during the past several years to establish a thorough and exhaustive inventory of materials.

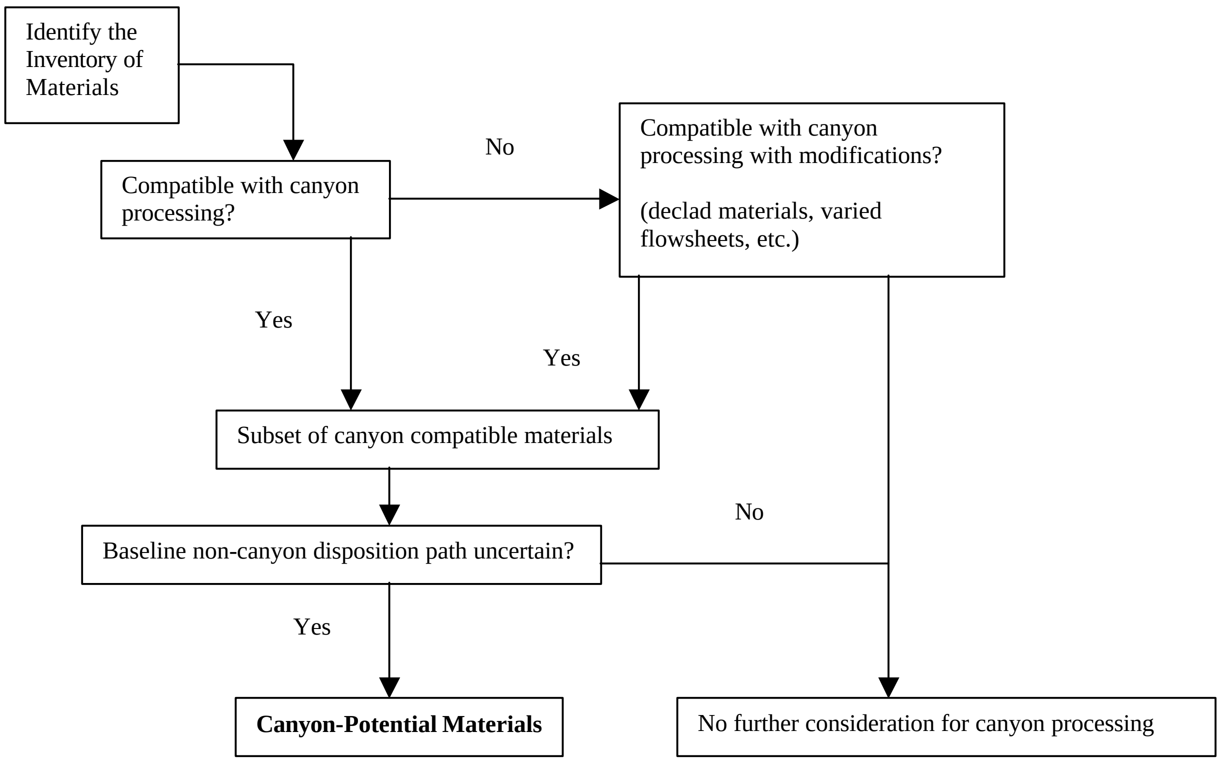


Figure 2
Generic Process Used to Screen Universe of Materials for Canyon-Potential

As part of the major activities described in Section A, above, DOE developed a database using the following approach:

1. Nuclear Materials Stewardship subject matter experts used the DOE Nuclear Materials Management and Safeguards System (NMMSS) as the original basis for material identification. This system is the official source of DOE nuclear material accountability information.

2. These subject matter experts then "cross-walked" all other known nuclear materials databases and information systems to NMMSS. Examples of these systems include:

   - The Office of Fissile Materials Disposition Plutonium Feed Report;
   - The Highly Enriched Uranium Program Document and Computerized Accountability Data System;
   - The National Spent Nuclear Fuel Database;

- DOE's annual Nuclear Material Inventory Assessment, and
- Site-specific accountability systems, such as the Local Area Network Material Accountability System employed at most major sites.

Using this input, site Nuclear Materials Managers and subject matter experts then conducted specific activities to identify the inventory of materials that were compatible with canyon processing.

The next step was to evaluate the disposition plan for each of the materials. All the materials with disposition paths that had any uncertainties or disposition paths that were undecided were catalogued as canyon-potential materials. This conservative approach (i.e., probably over-estimating materials that could require use of the canyons) was pursued in order to ensure that no materials were prematurely eliminated.

2. Identification of Canyon-Potential Materials - Results

By the summer of 1999, a consolidated listing of 23 canyon-potential materials had been compiled. Since then, the Department has added six additional canyon-potential materials to the list. This consolidated listing of 29 categories (grouping of like materials), is provided in Table 1. The six additional materials include:

- One new category of material, plutonium-contaminated enriched uranium (EU), which the Office of Defense Programs is in the process of declaring to be excess (Reference AC). This material is being maintained in a separate category because of its National Security status.

- Europium control elements, which were under evaluation when the list was compiled (Reference X). A more complete review indicated that this material should be added to the canyon-potential list.

- Four other categories of materials originally scheduled to be processed in the canyons. Three of these materials now have non-canyon disposition paths (Reference Z, AA, and AB), and one (Reference Y) is under active review.

These materials will remain on the canyon-potential list until they are either dispositioned via non-canyon options or a determination is made that canyon processing is needed.

Table 1
Consolidated Listing of Canyon-Potential Materials

Reference	Material Category
A	Off-Specification HEU
B	RFETS EU/Pu Classified Components (~85 items)
C	RFETS EU Components with Pu Contamination (~250 items)
D	EU Contaminated with Pu
E	Sand, Slag and Crucibles (RL, LANL)
F	U-233
G	Low Grade Pu Oxides (20-30%)
H	Irradiated Sodium Bonded EBR II and Fermi-I Blanket
I	LAMPRE Fuel
J	Plutonium Residues (10-20%)
K	Oak Ridge Type III Off-Specification HEU Metal
L	Foreign Research Reactor/Domestic Research Reactor (FRR/DRR) Spent Nuclear Fuel
M	High-Purity Pu Oxides and Metals
N	Hanford Off-Specification HEU
O	Scrap, Samples and Standards (Pu-239)
P	RFETS Depleted Uranium (DU) and DU/Pu
Q	INEEL Reactor Fuel (lightly or unirradiated reactor fuel)
R	Portsmouth Oxide
S	Nuclear Fuel Services (NFS) Off-Specification HEU
T	Cesium/Strontium (Cs/Sr) Capsules
U	Np 237/Pu 238 Production Mission
V	U Core N Reactor Fuel
W	Scrap, Samples and Standards (Other Transuranics)
X	Europium Control Elements
Y	Mark 18A Targets at SRS
Z	RFETS Sand, Slag and Crucibles (SS&C)/Fluorides
AA	Hanford High-Assay SS&C/Fluorides/Aluminum Alloys
AB	SRS & OR Off-Specification HEU Alloy (Type II Ingots)
AC	Additional EU Components with Pu Contamination (LANL, LLNL and Y–12 Plant)

C. Analysis Of Canyon-Potential Probability

After the canyon-potential materials had been identified, the next step was to evaluate the present plan or disposition baseline for each category of materials, identify any uncertainties, and determine what was being done or would be done to resolve the uncertainties. The result of this analysis was to assign each of the materials to one of the groups described below:

- **Materials With Pathways Under Active Review**. These materials do not, at present, have an established disposition baseline and could potentially be processed in the canyons. These materials are the subjects of current studies, and final disposition recommendations will be made in the near-term. This list is relatively small. (Table 2).

- **Materials With Non-Canyon Pathways With Significant Remaining Uncertainty**. These materials have non-canyon disposition pathways that have significant remaining uncertainty and require further action and issue resolution. Therefore, it is possible that the primary disposition path for one or more of the materials may prove infeasible and canyon processing could be an alternative. (Table 3)

- **Materials With Established Non-Canyon Baselines With A Moderate Probability Of Success**. Materials in this group have established disposition baselines that have a moderate probability of success and will be periodically monitored. Although the primary disposition paths for these materials are likely to succeed, unforeseen difficulties may arise and canyon processing may possibly be a viable alternative. (Table 4)

- **Materials With Established Non-Canyon Baselines No Longer Requiring Canyon Backup**. These materials have established baselines that were regarded as sufficiently mature so as to require no further canyon support considerations. No monitoring is required unless circumstances change. (Table 5)

Specific discussion on materials in each group is provided below.

1. Materials With Pathways Under Active Review

Table 2, below, provides specific information on materials with pathways under active review.

Disposition alternatives for unallocated off-specification (UOS) HEU are being evaluated in a joint study conducted by EM and the Office of Fissile Material Disposition. The term "off-specification" refers to whether the material meets American Society for Testing and Materials (ASTM) specifications for commercial nuclear fuel. Two types of surplus, or proposed to become surplus, off-specification HEU materials are addressed in both the UOS study and this Nuclear Material Identification Study[1]: (1) **Off-specification HEU**; and (2) **HEU/Pu composites**. The preliminary results of the UOS Study indicate that most of these two types of materials could be processed in the SRS H Canyon for ultimate disposition via reuse as Tennessee Valley Authority (TVA) commercial nuclear fuel. The remainder of the material could be processed through the Plutonium Immobilization Plant (PIP) or disposed as transuranic or high-level waste. DOE expects to finalize the UOS Study in March 2001. The results will be further evaluated for their impacts on future H Canyon operations. Processing these materials in F Canyon would not allow recovery of HEU for reuse.

[1] The UOS study also addresses materials (not addressed in this Nuclear Material Identification Study) that were considered off-specification, mainly because of uranium-236, which are characterized by much lower dose rates due to the absence of other actinide constituents. Therefore, they do not require use of the SRS canyons as they can be processed using Y-12 or commercial facilities.

Table 2
Materials with Pathways Under Active Review

Material	Cross-Walk*	Quantity	Anticipated Facility Use
Off-Specification (Off-Spec) HEU			
• Off-spec HEU contaminated with actinides	**A**	1.7 MT at Idaho; misc. kg quantity at SRS, INEEL and Y-12	Processing in H Canyon for Tennessee Valley Authority (TVA) program under consideration.
• Off-spec HEU contaminated with Pu	**N**	0.5 MT at Hanford	Based on new characterization data, this material (actually ~20 kg versus 500 kg) is included in Category D below.
• HEU parts contaminated with Pu	**C**	~ 250 items at RFETS	Processing in H Canyon for TVA program under consideration.
• EU contaminated with Pu	**D**	100s of kgs (mostly oxide) at RFETS, RL, ANL-W, LANL, SRS, & INEEL	Disposition via Plutonium Immobilization Plant (PIP) or waste disposal facility under consideration. Processing select HEU-rich items in H Canyon for TVA program under consideration
• Additional HEU parts contaminated with Pu	**AC**	At Y-12, LANL, and LLNL	Processing in H Canyon for TVA program under consideration.
HEU/Pu			
• HEU/Pu composites	**B**	85 items at RFETS	Processing in H Canyon for TVA program under consideration.
Mark 18 A Targets	**Y**	65 assemblies at SRS	SRS Canyons and off-site facilities are being assessed for Pu-244 recovery.

* This column provides a crosswalk with the consolidated listing of canyon materials in Table 1.

The Department has been conducting an in-depth review of the need for the various isotopes in the 65 **Mark-18A targets** currently being stored at SRS. An early finding of the review was that the americium and curium isotopes were neither needed nor was retention economically justifiable from a programmatic perspective. However, the Department has concluded that the Pu-244 shall be designated as a National Resource material. This material performs a unique function in high-accuracy measurements of plutonium for both safeguards and environmental analyses. The Department is studying the cost and feasibility of the various options, including the use of the SRS canyons for extracting the Pu-244 from the Mark-18A targets; or retrieval, packaging and shipment to Oak Ridge National Laboratory (ORNL) for isotope recovery; with a report to be completed in June 2001. If separation proves not feasible, the targets will be declared surplus and can be processed in H Canyon. Because a specific disposition option has not been selected, the Mark 18A targets remain under active review.

2. Materials With Non-Canyon Pathways With Significant Remaining Uncertainty

Table 3, below, provides specific information on materials with pathways that have significant remaining uncertainty.

Table 3
Materials With Non-Canyon Pathways With Significant Remaining Uncertainty

Material	Cross-Walk*	Quantity	Anticipated Facility Use
Pu-239 scrap, samples and standards	**O**	10s of kg Pu	Under evaluation. Vast majority will not require canyon processing.
TRU scrap, samples and standards	**W**	< 10 kg TRU	
Europium control elements	**X**	10-20 kg HEU	Direct disposal in a geologic repository.
Lightly or unirradiated reactor fuel	**Q**	~ 500 kg HEU and additional other metal	Direct disposal in a geologic repository or recycle via non-canyon facility.
LAMPRE fuel (tantalum clad)	**I**	Classified	Direct disposal in a geologic repository.

* This column provides a crosswalk with the consolidated listing of canyon materials in Table 1.

The Pu-239 scrap, samples and standards and the **transuranic scrap, samples and standards** in this group have undecided disposition paths and are under evaluation. Results so far from the evaluation are that very few, if any, of these scrap, samples, and standards would actually need canyon processing. This conclusion is based on a thorough on-site assessment of the large variety of these materials at RFETS, which are believed to be representative of these types of materials complex-wide. It was determined that no material at RFETS in these categories will need canyon processing. Instead, RFETS plans to package this material to meet the Pu-239 Long-Term Storage Standard (DOE-STD-3013-2000), ship to another site for reuse, or discard as waste. DOE believes this approach will be verified for other DOE sites as well. Should a material be identified that needs to be processed in the canyons, it could be processed in H Canyon. Furthermore, while there are a lot of items in these two categories (**Pu-239** and **transuranic scrap, samples, and standards**), they only amount to tens of kilograms of fissile material; thus the length of time for any canyon processing required would be minimal.

In addition to the two categories of materials discussed above, possible disposition pathways for **unirradiated reactor fuel** will be developed. This material consists of reactor fuel and other fuel components located at various DOE and university facilities throughout the United States. An analysis will be done to determine whether the nuclear material should be recovered for reuse in commercial fuel or whether direct disposal in a geologic repository should be pursued. For reuse, the necessary processing could be done using commercial facilities or facilities at Oak Ridge National Laboratory and would not require use of the canyons.

Lightly irradiated reactor fuel, Los Alamos Molten Plutonium Reactor Experiment (LAMPRE) fuel, and **europium control elements** are being evaluated for direct disposal by the National Spent Nuclear Fuel Program (NSNFP). This program is actively working with the Office of Civilian

Radioactive Waste Management (RW) to ensure acceptance of DOE spent nuclear fuel (SNF) at the planned repository. For the past three years, NSNFP and RW have worked jointly on analytical efforts to demonstrate and document the DOE SNF compliance with expected repository acceptance criteria. The effort has included total system performance assessment for radionuclide transport, criticality analyses (both pre and post-closure), and preclosure design basis events. All DOE SNF will be included in the repository license application, which will be submitted by RW in the near future. The repository waste acceptance criteria is moving to performance-based requirements that will aid in demonstrating compliance for DOE SNF. Efforts are also under way to resolve safeguards and security issues that may be introduced by the inclusion of DOE SNF in the repository. This effort is focused on minimizing additional security measures while ensuring that safeguards and security issues are fully addressed.

3. Materials With Established Non-Canyon Baselines With A Moderate Probability Of Success

Table 4, below, provides specific information on materials with established non-canyon baselines with a moderate probability of success.

Table 4
Materials With Established Non-Canyon Baselines
With a Moderate Probability of Success

Material	Cross-Walk*	Quantity	Anticipated Facility Use
Hanford high-assay SS&C/fluorides/aluminum alloys	**AA**	20 kg Pu in 25 containers	SS&C/aluminum alloys: Dispose in WIPP Fluorides: oxidize, disposition via PIP
RFETS SS&C/fluorides	**Z**	~ 270 kg Pu	Dispose in WIPP
Hanford/LANL low-assay SS&C	**E**	~ 60 kg Pu	Hanford: Dispose in WIPP LANL: Dispose in WIPP or PIP
SRS & OR off-spec HEU alloy (Type II ingots)	**AB**	~ 8 MT HEU	Commercial vendor processing (pending Tennessee Valley Authority (TVA) agreement)
Off-spec HEU metal at OR (Type III)	**K**	~ 10 MT HEU	Commercial vendor processing (pending TVA agreement)
Cs/Sr capsules	**T**	~ 72M Ci	Vitrify in future Hanford vitrification facility
Low-grade Pu oxides (20-30% Pu)	**G**	~ 320 kg Pu	Blend up for PIP
Pu residues (10-20% Pu)	**J**	~ 400 kg Pu	Blend down and dispose in WIPP or blend up for PIP
U-233	**F**	1460 kg U at ORNL.	Commercial vendor processing pending
FRR/DRR SNF	**L**	~ 18 MTHM	Disposition via Melt and Dilute technology

* *This column provides a crosswalk with the consolidated listing of canyon materials in Table 1.*

This material, including Pu residues and low-grade oxides; U-233; Cs/Sr; foreign and domestic research reactor spent nuclear fuel; and off-specification HEU that is part of the TVA Agreement, is not thought to require canyon processing due to the progress being made on the current non-canyon baseline alternatives.

Plans for the disposition of Hanford, Rocky Flats, and Los Alamos National Laboratory **sand, slag and crucibles, fluorides, and aluminum alloys** include one of the following: to direct dispose these materials in WIPP using the Nuclear Regulatory Commission (NRC) certified pipe overpack package and a Safeguards Termination Limit (STL) variance; or process the material on-site and package it to the DOE Long-Term Storage Standard. Rocky Flats and Hanford have already obtained a Safeguards Termination Limit variance from DOE Headquarters for these materials.

The **Off-specification HEU** in this group (the **Type II and Type III material**) is currently part of the pending TVA Agreement with DOE, and it is to be commercially blended down to low-enriched uranium, irradiated in specific TVA reactors, and dispositioned as commercial SNF. The TVA Agreement is to be finalized in early Calendar Year 2001.

The **cesium/strontium** within the DOE complex contains a significant amount of chlorides and is contained in double-walled stainless steel capsules, which complicate the ability for the SRS canyons to process these materials. The current plans are to maintain this material in its current storage configuration and disposition the majority of it after 2010 via the future Hanford Vitrification Facility or by treatment and packaging for disposal as low-level waste. More extensive studies are in progress to support this effort.

The **plutonium oxides and residues** that contain **between 10 wt.% and 30 wt.%** plutonium currently are either too lean to package to the DOE Long-Term Storage Standard (< 30 w% Pu + U) or too rich to direct dispose in WIPP (> 10 wt.% Pu). Plans are to blend this material up to meet the Long-Term Storage Standard or blend down to dispose in WIPP. The Office of Fissile Materials Disposition (NN-60) has determined that most of these materials, including groups of RFETS residues, can be blended up using methods that are acceptable for dispositioning via the Plutonium Immobilization Plant, and has revised its acceptance guidance accordingly through case-by-case evaluations.

All the **U-233** materials contain a radioactive nuclide daughter of U-233 (Th-229), which is the parent isotope for a potential cancer treatment (Bi-213). A Draft Request for Proposals (RFP) was issued on January 31st, 2001, to explore commercial interest in a private contract for extraction of the medical isotopes and preparation of the U-233 materials for storage prior to direct disposal. Non-canyon processing options exist for these materials.

The aluminum-based **foreign and domestic research reactor (FRR/DRR) spent nuclear fuel** is to be prepared for disposition using the Melt and Dilute process under development at the Savannah River Site. To ensure availability of the capability to prepare this fuel for disposal and, if necessary, stabilize fuel for health and safety reasons, H Canyon processing will be retained until implementation of the technology has been demonstrated.

4. Materials With Established Non-Canyon Baselines No Longer Requiring Canyon Backup

Some materials in this group are no longer considered compatible with canyon processing, would require extensive canyon modification, or have already been processed by a non-canyon alternative. Their status is still being tracked because the canyons were once considered a viable alternative. For the other materials, either the established baseline is being implemented or alternative non-canyon options have been identified such that the canyons are no longer considered a back-up. Specific information on these materials is provided in Table 5.

Table 5
Materials With Established Non-Canyon Pathways No Longer Requiring Canyon Backup

Material	Cross-Walk*	Quantity	Anticipated Facility Use
High-purity Pu metal/oxides	**M**	Up to 33 MT Pu	Disposition via irradiation as mixed oxide fuel
U Core N Reactor fuel	**V**	~ 2100 MTHM	Direct disposal in a geologic repository
RFETS DU & DU/Pu	**P**	~ 660 kg DU	Dispose in WIPP or at the Nevada Test Site
Np-237/Pu-238 production mission	**U**	**N/A**	Production at the Oak Ridge Radiochemical Engineering Development Center (REDC) Facility
Portsmouth oxide	**R**	~ 1 MT HEU	Commercial vendor will disposition
NFS off-Spec HEU	**S**	~ 300 kg HEU	Commercial vendor has dispositioned
Irradiated, sodium-bonded EBR II, Fermi I blanket	**H**	260 kg Pu in 57 MTHM	Disposition via electrometallurgical technology for EBR II and non-canyon alternative for Fermi I

* This column provides a crosswalk with the consolidated listing of canyon materials in Table 1.

V. CANYON FACILITIES DETERMINATION

A. Introduction

As noted earlier, a great deal of effort was expended in identifying all nuclear materials in the DOE inventory and their associated disposition pathways. A large subset of that effort was to identify those specific materials that would potentially require canyon processing and, additionally, to establish the likelihood that canyon processing would be needed. The results of that review are presented in Tables 2 through 5. With that effort now complete, a determination is needed to establish which canyon would be used if processing of any of these materials were required. While the current schedule has F Canyon PUREX operating through Fiscal Year 2002 and H Canyon operating through Fiscal Year 2008, there may be some changes to these schedules as near-term decisions on canyon-potential materials are made. To understand if any of the canyon-potential materials require one canyon over another, this section provides a brief description of the unique features and capabilities associated with each canyon and their associated facilities.

Both canyons and accompanying B-Lines were originally built to the same plans with the exception of FA-Line for uranium oxide production. FA-Line was used to convert depleted uranium from both F and H Canyons to oxide. F Canyon and FB-Line were modified in the late 1950s to handle a higher throughput of depleted uranium (metric tons/day range) and plutonium. The larger equipment installed limited the U-235 to less than 1.00% enrichment but increased the plutonium residue stabilization capacity by approximately three times. The Second Product cycle of solvent extraction remained unchanged from H-Area. In addition, in the late 1970s, the Multi-Purpose Processing Facility (MPPF) was installed in F Canyon and was operated to recover Am-241. FB-Line has produced several grades of plutonium in the metal or oxide state. FB-Line can recover, concentrate, and purify a variety of scrap materials. In addition to the modifications to increase plutonium production in the late 1950s, FB-Line has been modified to directly recast plutonium metal and to place plutonium in 3013 inner cans.

H Canyon was modified in the early 1960s to recover HEU at a throughput in the kilogram/day range and neptunium. The HEU can be processed through the entire canyon and HA-Line as HEU and can produce LEU of any isotopic value. Also in the 1960s, the "Frames" equipment was installed in H Canyon for Pu-238 separation and recovery. The existing HB-Line converted neptunium, plutonium, and Pu-238 to oxide. A new HB-Line was built to replace the old HB-Line in the 1980s and it has the capability to dissolve Pu/U/Np scrap, produce Pu or Np oxides, and produce Pu-238 oxide from canyon solutions.

B. Assessment Results

If any of these canyon-potential materials should need canyon processing, the Department has examined whether or not there are compelling arguments that would drive the use of one canyon over the other. In discussions with the DNFSB staff, 13 categories of materials were identified that had the potential for being processed in F Canyon. Specific discussions of these categories are provided in Appendix 3. Based on reviews by SRS operations personnel, DOE determined that all of the canyon-potential materials could be processed in H Canyon or MPPF, and none specifically requires the use of F Canyon PUREX.

VI. CONCLUSIONS

For the past three years, the Department has engaged in extensive activities to identify with high confidence all materials in the complex for which canyon operations should be considered. Numerous studies, data calls, reviews of materials tracking systems, site visits, and other techniques have been employed. Based on the work conducted, the following conclusions can be drawn:

1. DOE has an excellent understanding of its inventory of nuclear materials and spent nuclear fuel.

2. Some of DOE's surplus nuclear materials and spent nuclear fuel do not have defined disposition pathways or have pathways with significant uncertainties.

3. Based on in-depth reviews of these materials, DOE is confident that it has identified essentially all those potentially requiring canyon processing.

4. A small fraction of the canyon-potential materials may actually require canyon processing.

5. None of these materials requires the use of the F Canyon PUREX process.

In summary, F Canyon has been operating since 1995 to stabilize “at risk” nuclear materials and spent fuel from throughout the DOE complex. Processing of the limited amount of remaining material will be complete in the near future and no additional materials requiring F Canyon PUREX to remain operational (i.e., cannot be processed in H Canyon) have been identified.

VII. PATH FORWARD

In the next few months, the Department will complete its analyses of the seven categories of materials that are under active review. The first of these is the unallocated off-specification HEU study expected to be complete in the near future. Preliminary results indicate that H Canyon may be the preferred processing option for most of these materials. The second effort is evaluating options to recover Pu-244 from the Mark 18A targets. No consensus has been reached on whether use of either canyon can be a reasonable alternative. Additionally, the Department is evaluating options for retrieval of the Mark 18A targets from storage, with subsequent packaging and shipment to ORNL for isotope recovery. These issues are being addressed in the cost and feasibility study scheduled to be complete in June 2001.

For the remaining categories of canyon-potential materials, DOE is pursuing the following activities:

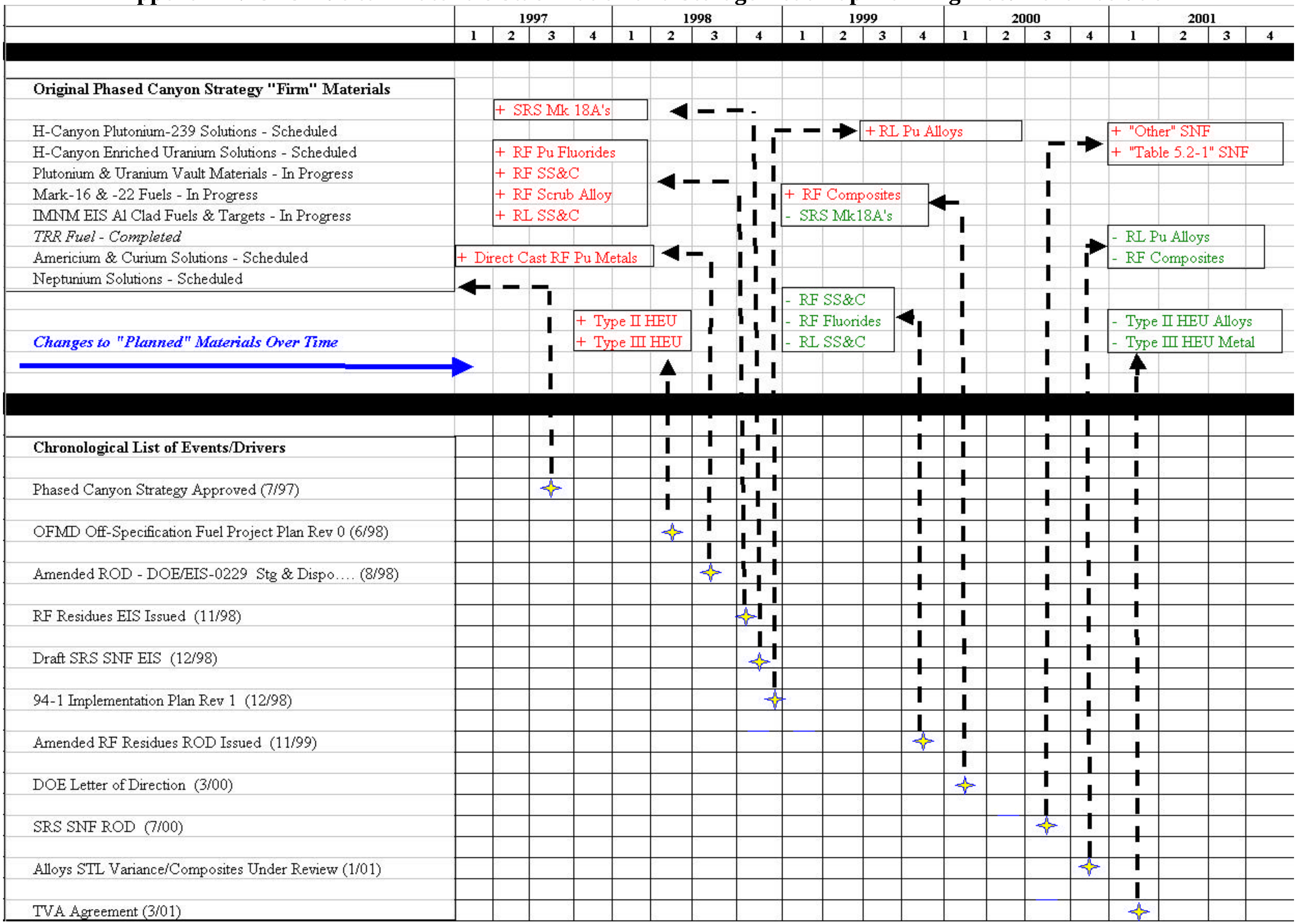
1. Resolve disposition paths for the limited amount of nuclear materials that have an undecided pathway.

2. Monitor to resolution each of the categories of materials with uncertainties in their established baselines, to include issue resolution associated with direct disposal in a geologic repository.

DOE anticipates that these efforts will identify very few materials that will require canyon processing support, and that those that do could be processed in H Canyon.

Finally, the Department is currently evaluating the impacts associated with the use of H Canyon for additional missions, as well as the impacts of H Canyon remaining operational as a backup capability. If the impacts on H Canyon are significant, i.e., would require several additional years of operation, DOE could consider limited use of F Canyon for certain materials if it is more cost effective.

Appendix 1: SRS Nuclear Materials Stabilization and Storage Roadmap Planning Document Evolution



Appendix 2: Materials Identified for Possible Canyon Processing by the Processing Needs Assessment

Material Category	Specific Material	Site	Current Disposition Plan
Spent Nuclear Fuel	Single Pass Reactor Fuel (3 metric tons uranium)	Hanford	Direct disposal in a geologic repository.
	Misc. damaged fuels (0.5 metric tons uranium)	Various: Idaho, Oak Ridge, Hanford	Direct disposal in a geologic repository.
Plutonium	Classified metal parts (recast only) (390+ items)	Rocky Flats	Declassify in FB Line and package for surplus plutonium disposition.
	Aluminum alloys and compounds (~100 items)	Hanford	Aluminum alloys: Direct disposal in WIPP Compounds: package to long-term storage standard pending disposition in PIP.
	Unirradiated plutonium tubes (38 Mark 42 targets)	SRS	Currently being processed in F Canyon.
Special Isotopes	Misc. targets (65 Mark 18A targets)	SRS	SRS canyons and off-site options being assessed for Pu-244 recovery.

Appendix 3: F Canyon-Potential Materials Information Sheets

RFETS Composite Parts
(Reference "B")

Location: Rocky Flats Environmental Technology Site (RFETS)

Quantity: ~85 Pu/highly enriched uranium (HEU) parts.

Background: These materials are "excess to National Security" but are in classified shapes and configurations. The plutonium levels in this material are too high for receipt at the Oak Ridge Y-12 Plant National Security Complex (Y-12), and RFETS no longer has the capability to process the parts to remove or reduce the plutonium levels.

Present Plans/Disposition Baseline: Based on preliminary results of a joint study conducted by NN-60 and EM, the composite parts could be dissolved in the H Canyon facilities, with the Pu separated for conversion to oxide packaged to meet the DOE Long-Term Storage Standard and sent to the Plutonium Immobilization Plant for disposition. The HEU could be blended down for disposition as fuel through the TVA Off-Specification Program.

The only major alternative to this plan is to transfer the parts to Los Alamos National Laboratory (LANL) for oxidation. The resulting declassified oxide would be packaged to DOE's Long-Term Storage Standard for storage prior to immobilization, although some oxide batches may have low enough Pu content for acceptance by Y-12.

Canyon Options: F Canyon could be used for dissolving and Pu stabilization, but processing in H Area would support the recovery and reuse of HEU.

Canyon Impacts: Utilization of H Canyon requires three dissolver years (plus three years of concurrent support from FB Line in resizing). F Canyon processing would require approximately two years but is a less attractive alternative than use of H Canyon because the HEU could not be recovered.

Mark 18A Targets at SRS
(Reference “Y”)

Location: Savannah River Site (SRS)

Quantity/Condition: 65 aluminum-clad, irradiated assemblies

Background: Mark 18A assemblies were part of the californium production program and have been in reactor production or storage at SRS since the mid 1970s. In November 1999, the Nuclear Materials Council evaluated needs for isotopes contained in the targets. The DOE Offices of Nonproliferation and National Security (NN) and Security and Emergency Operations (SO) concluded that the Pu-244 in the targets represents ~90% of the world’s inventory and is needed for high-accuracy measurements of plutonium for both safeguards and environmental analyses.

Present Plans/Disposition Baseline: Continue to store targets in the SRS Receiving Basin for Offsite Fuels (RBOF), with subsequent transfer to the SRS L-Basin in FY 2002. A DOE Study, to be completed in June 2001, will explore siting and funding options, including international support for the recovery of the Pu-244 to further its use in nonproliferation and environmental programs. With the present plans and schedules, Fiscal Year 2005 is the most likely timeframe that implementation of such a program could be initiated. If no viable pathway is defined for retention of the material for programmatic use, EM will explore options for disposal of the targets.

Canyon Options: For Pu-244 recovery, processing in either F or H Canyon would require 3-4 dissolver months plus 6 months of B-Line or Multi-Purpose Processing Facility (MPPF) processing for stabilization. The cost and technical feasibility issues with using either canyon as well as other off-site options (i.e., packaging and shipping the targets to ORNL) for Pu-244 recovery are being evaluated in the current study. The targets could be processed in either F or H Canyon, requiring 1-2 dissolver months, if DOE decides to dispose of them without recovering the Pu-244.

Canyon Impacts: Pending programmatic decisions, the maximum impact on canyon operations is three-to-four dissolver months. It is uncertain at this time whether it would be technically feasible or cost effective to use either canyon for Pu-244 recovery.

Los Alamos Molten Plutonium Reactor Experiment Fuel
(Reference "I")

Location: Hanford, in three Experimental Breeder Reactor II (EBR-II) spent fuel casks in an 8-ft diameter, cylindrical concrete vault inside the Plutonium Finishing Plant (PFP) security perimeter.

Quantity: Classified; material is a Pu-Fe alloy (10 atomic percent iron) in tantalum-clad tubes

Background: The Los Alamos Molten Plutonium Reactor Experiment (LAMPRE) was a reactor program based on the utilization of liquid plutonium as a fast breeder fuel. Upon completion of the program, approximately 20 containers of the LAMPRE fuel were shipped to Hanford. Three containers have significant quantities of Pu and are stored within the PFP. The other containers have been sent to the Hanford burial grounds and disposed of as waste.

Present Plans/Disposition Baseline: This material will be stored at PFP pending transportation to a geologic repository for direct co-disposal with high-level waste. Although some special safeguards and security measures may be required at the repository surface facility due to the amount of Pu involved, and poison material may be added to the disposal canister to control criticality, there are no disposal issues particular to this material. Should unforeseen difficulties arise with direct co-disposal, electrometallurgical treatment or the melt and dilute process could be pursued.

Canyon Options: Fuel must be declad before treatment. Decladding of the LAMPRE tubes could be conducted at the Argonne National Laboratory-West facilities. The declad material would then be transported to SRS. The resulting fuel would be dissolved and the Pu recovered and stabilized to DOE's Long-Term Storage Standard for disposition. Either F or H Canyon could be used, requiring one dissolver month in F Canyon or two-to-three dissolver months in H Canyon.

Canyon Impacts: None expected. If the baseline plan experiences difficulties, several non-canyon alternatives, mentioned above, are considered to be more attractive.

Hanford High-Assay Sand, Slag, and Crucibles (SS&C)/Fluorides/ Aluminum Alloys
(Reference "AA")

Location: Hanford

Quantity: ~20 kg Pu

Background: The Plutonium Sand, Slag, and Crucible Trade Study, completed by DOE in January 1997, concluded that the higher assay material could be sent to SRS for processing, but could also be cemented and sent to WIPP. More recently, with the opening of WIPP in March 1999 and resolution of packaging and safeguards issues that had previously made disposal of these residues in WIPP uncertain, there is no driver for sending these materials to SRS for canyon processing. There has not been a viable path forward for the fluorides or the aluminum alloys until recently, but RFETS has successfully developed a plan to dispose of fluorides in WIPP.

Present Plans/Disposition Baseline: The high-assay and low-assay Hanford SS&C inventories will be blended to ensure that the material is below the current WIPP acceptance limit of <10% Pu. The plutonium/aluminum alloys are already <10% Pu. These materials will be packaged in a pipe overpack container and shipped to WIPP. Fluorides represent only a small amount of Pu, and Hanford will process the material to oxide in its Plutonium Support Laboratory. The oxide will be packaged according to DOE's Long-Term Storage Standard and dispositioned in the Plutonium Immobilization Plant.

Canyon Options: F Canyon was previously evaluated and shown to require approximately 12 dissolver months for the entire inventory. Processing in H Canyon would be equally suitable.

Canyon Impacts: None expected. These materials have well-defined disposition pathways to WIPP disposal or immobilization.

RFETS Sand, Slag, and Crucibles (SS&C)/Fluorides
(Reference "Z")

Location: Rocky Flats Environmental Technology Site (RFETS)

Quantity: ~270 kg Pu

Background: The first Record of Decision (ROD) for the RFETS residues and scrub alloy environmental impact statement (issued November 25, 1998) decided that RFETS SS&C would be sent to SRS for processing. However, with the opening of WIPP in March 1999 and resolution of packaging and safeguards issues, which had previously made disposal of these residues in WIPP uncertain, the baseline plan was changed. The first ROD was subsequently amended (August 25, 1999) to allow SS&C residues to be repackaged and disposed of in WIPP, and no significant driver remains to maintain canyon processing at SRS as a primary option. Likewise for plutonium fluoride residues, there are no longer cost, waste management, or schedule advantages to processing them in the canyons. DOE has now decided to blend down the plutonium fluoride residues with a matrix of inert material to less than ten percent and dispose of these residues in WIPP.

Present Plans/Disposition Baseline: RFETS will package the SS&C and fluorides in pipe overpack component containers and ship them to WIPP for disposal.

Canyon Options: Either F Canyon or H Canyon would have been equally suitable for the treatment, requiring approximately 51 dissolver months for the listed inventory.

Canyon Impacts: None expected. These materials have well-defined disposition pathways to WIPP.

Low-Assay Sand, Slag and Crucibles (SS&C) (Hanford, LANL)
(Reference "E")

Location: Hanford; Los Alamos National Laboratory (LANL).

Quantity: ~60 kg Pu.

Background: The Plutonium Sand, Slag, and Crucible Trade Study, completed by DOE in January 1997, recommended that the low-assay portion of the Hanford inventory should be cemented and sent to WIPP. Treatment at SRS was considered for a portion of this material if the high-assay portion of the Hanford inventory were processed there. Hanford decided to cement all of this material and dispose of it in WIPP. With the opening of WIPP in March 1999 and resolution of packaging and safeguards issues that had previously made direct disposal of these residues in WIPP uncertain, there is no need to send these materials to SRS for canyon processing.

Present Plans/Disposition Baseline: Hanford will direct dispose low-assay SS&C in WIPP. Essentially, all of the LANL inventory was stabilized in FY 1997, with the exception of 19 items originally used in research and as standards. Those items were inspected and no unstable items were noted. The LANL inventory will be dispositioned in the Plutonium Immobilization Plant or WIPP.

Canyon Options: Approximately 19 dissolver months would have been required to process the entire inventory through F Canyon and FB Line. H Canyon would have been an equally acceptable option.

Canyon Impacts: None expected, as materials will be shipped to WIPP or the Plutonium Immobilization Plant.

Low Grade Pu Oxides (20-30% Pu)
(Reference "G")

Locations: Various locations, including Argonne National Laboratory–West (ANL-W), Lawrence Livermore National Laboratory (LLNL), Rocky Flats (RFETS), Hanford (RL), and Los Alamos National Laboratory (LANL).

Quantity: ~320 kg Pu

Background: These materials are too lean in Pu to package to meet DOE's Long-Term Storage Standard because they do not contain >30% actinides (usually plutonium plus uranium), and are too rich to be disposed in WIPP because they contain more than 10% Pu content. However, sites can blend materials up to greater than 30 wt.% actinide content, provided the blend would meet the Office of Fissile Materials Disposition's (NN-60) acceptance criteria for the Pu disposition program.[2] NN-60 recently changed its acceptance criteria to allow RFETS to combine certain Pu metals and oxides in a way that would meet both the Long-Term Storage Standard and immobilization acceptance criteria. Similar evaluations will be conducted, if necessary, for ANL-W, LLNL, RL, and LANL.

Present Plans/Disposition Baseline: ANL-W will passivate, blend, and package these materials to DOE's Long-Term Storage Standard. However, the site does not currently have a Pu glovebox facility configured to complete these tasks. An estimated 10% of the items (210) will require additional processing for disposition, and ANL-W will seek assistance from another site with an existing capability to package to the Long-Term Storage Standard, if required. LLNL will stabilize and package to the Long-Term Storage Standard and revised plutonium immobilization acceptance criteria. RFETS will blend up, calcine, and package to the Long-Term Storage Standard. RL will stabilize and package to the Long-Term Storage Standard. Recent tests indicate that the oxide product from magnesium hydroxide precipitation of RL solutions will likely exceed (or approach) the 30% actinide target level for the Long-Term Storage Standard and would thus be acceptable to NN-60 for disposition, either directly or with minor batch blending. LANL will aqueously or thermally process residues to meet the Long-Term Storage Standard.

Canyon Options: The bulk of these materials could be processed in either F Canyon/FB Line or H Canyon/HB Line and converted to the Long-Term Storage Standard, as metal from FB Line or oxide from HB Line. An approximate two-year extension in F Canyon or H Canyon operations would be required if all of the items were processed in either of those facilities.

Canyon Impacts: None expected. These materials have sufficiently well defined disposition pathways, through onsite stabilization to meet the Long-Term Storage Standard and disposition in the Plutonium Immobilization Plant.

[2] *Acceptance Criteria for Plutonium-Bearing Materials to be Dispositioned by Immobilization,* DOE/MD-0011, December 1998.

Plutonium Residues (10-20% Pu)
(Reference "J")

Locations: Various locations, including Rocky Flats (RFETS), Hanford (RL), and Los Alamos National Laboratory (LANL).

Quantity: ~400 kg Pu

Background: The material is currently too lean in Pu to package it to meet DOE's Long-Term Storage Standard because it does not contain >30% actinides (usually plutonium plus uranium), and it is too rich to be disposed in WIPP because it contains more than 10% Pu content. Sites could blend materials up to greater than 30 wt.% actinide content, provided the blend would meet the Office of Fissile Materials Disposition's (NN-60) acceptance criteria for the Pu disposition program.[3] NN-60 recently formally changed its acceptance criteria to allow RFETS to combine certain Pu metals and oxides in a way that would meet both the Long-Term Storage Standard and immobilization acceptance criteria. Similar evaluations will be conducted, if necessary, for Hanford and LANL.

For the leaner Pu materials, WIPP disposition (via the pipe overpack container system) has been demonstrated by Hanford and RFETS for certain items that belong to site-specific scrap or residue material groups that average < 20 % Pu.

Present Plans/Disposition Baseline: RFETS will blend up, calcine, and package to the Long-Term Storage Standard. RL will either blend up to >30 % Pu and package to the Long-Term Storage Standard or blend down to < 10% Pu and package for disposal in WIPP. (Safeguards Termination Limit (STL) Variance approval has recently been granted to RL to allow disposal to WIPP.) LANL will process materials thermally or aqueously, as appropriate, and package to the Long-Term Storage Standard for transfer to the Plutonium Immobilization Plant (with an option to pursue WIPP disposal under the Safeguards Termination Limit variance for a portion of its residues).

Canyon Options: The bulk of these materials could be processed in either F Canyon/FB Line or H Canyon/HB Line and converted to the Long-Term Storage Standard, as metal from FB Line or oxide from HB Line, with relatively similar impacts between the two canyon options (approximately 3-5 years).

Canyon Impacts: None expected. These materials have sufficiently well defined disposition pathways, either for disposal in WIPP or through onsite stabilization to the Long-Term Storage Standard and disposition through immobilization. Where uncertainties remain, they involve tradeoffs in cost, schedule, and certification between the WIPP and immobilization options; therefore, canyon treatment is not considered a necessary backup option for current baselines.

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[3] *Acceptance Criteria for Plutonium-Bearing Materials to be Dispositioned by Immobilization,* DOE/MD-0011, December 1998.

U-233
(Reference "F")

Location: Various sites, including Oak Ridge National Laboratory (ORNL), Oak Ridge Y-12 Plant (Y-12), Idaho National Engineering and Environmental Laboratory (INEEL), Los Alamos National Laboratory (LANL), and Lawrence Livermore National Laboratory (LLNL)

Quantity:
ORNL - ~450 kg U-233 in ~1,460 kg U, various forms
INEEL -~360 kg U-233 in 14 metric tons of natural thorium
LANL/LLNL – minimal amounts of U various forms

Background: Large portions of the materials (particularly those at ORNL) are highly radioactive, requiring facilities with remote handling capabilities (hot cells). The majority of the material packages have not been physically examined in more than 20 years. The ORNL materials are in a variety of container types, material forms, and fissile contents requiring repackaging of the majority of the materials before any canyon processing could occur. Canyon processing of the INEEL materials would require facility, process, and equipment modifications because of their large thorium content and physical state. They could, however, potentially be incorporated into the Pu immobilization process without significant modifications, replacing the planned DU feed material in the individual canned ceramic pucks. All the U-233 materials contain a radioactive nuclide daughter of U-233 (Th-229) which is the parent isotope for a potential cancer treatment (Bi-213). DOE's management of the U-233 materials is the subject of Recommendation 97-1 of the Defense Nuclear Facilities Safety Board.

Present Plans/Disposition Baseline: DOE's initial efforts to identify a disposition path for the U-233 were carried out through a series of studies performed by NN-60 in FY2000. These studies identified a number of potential disposition pathways at three sites - INEEL, ORNL, and SRS. However, prior to finalization of the NN-60 studies, DOE became aware of the potential for using the U-233 as a source of one or more isotopes (^{229}Th, ^{225}Ac, and ^{213}Bi) that may become important in treatment of cancers (clinical trials are underway) while in the process preparing the U-233 for safe, long term, economical storage, including elimination of the need for criticality and safeguards and security controls. After conducting an evaluation of this new opportunity, DOE decided to adopt the following path forward. Specifically, DOE is in the process of issuing a Request for Proposal (RFP) to obtain the services of a contractor to perform the following: 1) to process and repackage the DOE inventory of U-233 materials stored in the Radiochemical Development Facility (Building 3019A) at ORNL to render it suitable for safe, long term, economical storage, including elimination of the need for criticality and safeguards and security controls, and, in the process, 2) to extract Thorium-229 (^{229}Th) for beneficial use from as much of the U-233 inventory as is practicable. These activities will be performed with an emphasis on ensuring safe interim storage and operations in Building 3019A, and achieving closure of DNFSB Recommendation 97-1 at ORNL. Other objectives include removal of U-233 materials from Building 3019A for long term storage and placing Building 3019A in safe and stable shutdown for transfer to EM for decommissioning. As part of this procurement, DOE plans to lease the ^{229}Th to the successful contractor for commercial beneficial use. Beneficial use of the leased ^{229}Th must support medical research and treatment, and reduce overall project costs or provide other financial benefits to the Government.

A draft of the RFP (DE-RP05-00OR22860) has been posted on the DOE/OR web site and announced in the *Commerce Business Daily*. Prospective offerors have been invited to comment on the Draft RFP as a means of ensuring to the greatest degree possible that the final RFP will result in viable proposals.

All of the technologies required to accomplish the scope of work expected to be required under the RFP have been accomplished at ORNL in the past. Accordingly, DOE considers that there is little risk of the RFP activity failing and does not expect to further consider use of the canyons for processing the U-233.

A plan for disposition of the INEEL U-233 materials is under development. The Zero Power Reactor (ZPR) plates at ORNL, LANL, and LLNL are being evaluated for programmatic use at Argonne National Laboratory (ANL) and/or transfer to ORNL for inclusion in the RFP. The other LANL and LLNL materials are slated for transfer to ORNL for inclusion in the RFP.

<u>Canyon Options</u>: The primary role evaluated for SRS support was the use of the Multi-Purpose Processing Facility (MPPF), located in the F Canyon, to support dissolution and transfer of ORNL U-233 materials to the F Area Tank farm for ultimate disposition via DWPF glass logs. Capture of the medical isotopes could be accomplished in MPPF[4]. However, as explained above, DOE is not pursuing this approach since a more attractive path forward has been developed.

<u>Canyon Impacts</u>: None expected. In the unlikely event that the RFP and following procurement process do not result in a contract, DOE will reevaluate all the potential treatment options, including the use of existing DOE facilities to effect disposition plans. However, none of the options proposed for the use of MPPF would be affected by the removal or use of aqueous processes in either F or H Canyon.

[4] Utilization of the MPPF for preparation of materials for disposal would not involve the F Canyon PUREX process. Equipment R&D work could be performed prior to the completion of Am/Cm work and removal of Am/Cm materials in the MPPF. Subsequent installation and startup of U-233 processing equipment would then require approximately one year, with an additional two to three years processing time to complete material disposition.

High-Purity Plutonium Oxides and Metal
(Reference: “M”)

Location: Various sites, including Pantex, Los Alamos National Laboratory (LANL), Hanford, Lawrence Livermore National Laboratory (LLNL), the Rocky Flats Environmental Technology Site (RFETS), and the Savannah River Site (SRS).

Quantity: Up to 33 metric tons Pu

Background: This material has been declared surplus and is part of the agreement between the U.S. and Russia concerning the management and disposition of plutonium designated as no longer required for defense purposes. The Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement (January 2000) states the Department will disposition up to 50 metric tons of surplus plutonium, including 34 metric tons of weapons-grade Pu, via irradiation or immobilization, and will construct three new facilities at the Savannah River Site. The high purity plutonium contained in the oxides and metal listed here will primarily become feed for the Mixed Oxide (MOX) Fuel Fabrication Facility.

Present Plans/Disposition Baseline: The high purity metals, mainly pits, will be processed over a ten-year period, beginning in 2006, to an oxide via a dry process in the Pit Disassembly and Conversion Facility (PDCF), then fabricated into fuel in the MOX facility. The MOX fuel will then be irradiated in a commercial reactor and dispositioned via the geologic repository as spent nuclear fuel.

Canyon Options: The SRS Canyons were considered as an option only to clean up the impurities associated with pit and metal conversion, as required. However, the MOX facility is now being designed to provide similar aqueous purification capability.

Canyon Impacts: None expected, as the MOX facility will address the impurity issue.

Uranium Core N-Reactor Spent Nuclear Fuel
(Reference "V")

Location: K East and K West Basins, Hanford.

Quantity: Approximately 2,100 metric tons of heavy metal (MTHM) of N-Reactor spent nuclear fuel (SNF), zirconium-clad, low-enriched uranium (LEU) core.

Background: The K East and West basins were built in the 1950s to provide temporary storage of fuel discharged from the K-Reactors until they were shut down in 1970. Subsequently, the basins were used for storage of N-Reactor SNF. The basins are not currently leaking, but they have been documented as leaking in the past.

Present Plans/Disposition Baseline: DOE developed a K-Basin recommended path forward to remove the fuel from the basins, stabilize it, and place it in safe, secure interim storage. Specifically, the K-Basins fuel and canisters will be retrieved from the current storage locations and cleaned, underwater, to remove corrosion products. The cleaned fuel will then be removed from the canisters, loaded into fuel baskets, transferred in baskets to multicanister overpacks, and vacuum dried at low temperature to remove free water. The cold vacuum-dried SNF will be shipped to the 200 East Area for interim storage in the Canister Storage Building pending disposal in a geologic repository. Additionally, the K-Basin sludge will be retrieved and transferred to interim storage at the T-Plant Canyon in the 200 West Area, prior to processing and ultimate disposal as remote-handled TRU.

Canyon Options: Fuel must be declad before treatment; a substantial capital investment would be needed to install a head-end process (chop-leach) to penetrate the zirconium cladding. Either F or H Canyon could be used to dissolve the SNF. For F Canyon, based on ~four metric tons of Pu in the SNF and current throughput rates in FB Line, it would take an estimated 10 years to process this SNF; a similar time period would be expected for H Canyon treatment.

Canyon Impacts: None expected. Should the baseline path of direct disposal in the geologic repository fail, a trade study would be initiated to evaluate processing options. The SRS canyons are not a primary option since a significant new head-end process, at a cost of hundreds of millions of dollars, would be required to enable the use of either canyon.

RFETS Depleted Uranium (DU) and DU/Pu
(Reference "P")

Location: Rocky Flats Environmental Technology Site (RFETS)

Quantity: ~660 kg DU

Background: This DU and DU/Pu material meets Nevada Test Site waste acceptance criteria for disposition as low-level waste or WIPP waste acceptance criteria for TRU waste disposal, with the exception that the items have classified contours, masses, and physical dimensions and, therefore, cannot be disposed until the classified aspects of the material are destroyed. Several drums have been categorized as low-level waste and can be sent to the Nevada Test Site for long-term management of classified material. The remaining drums are TRU waste, and WIPP is finalizing procedures to allow acceptance of classified material.

Present Plans/Disposition Baseline: A WIPP Security Plan has been approved by DOE for disposal of classified TRU waste in WIPP. DOE is preparing a decision package to enable disposal of classified TRU waste from RFETS to WIPP.

Canyon Options: This material could be processed in either F or H Canyon, requiring approximately one dissolver month in either canyon.

Canyon Impacts: None expected. Alternative methods to declassify the parts, including crushing (when adequate) and melting, are judged to be more attractive than dissolution should direct disposal of classified shapes not be possible.

Irradiated, Sodium -Bonded Spent Nuclear Fuel
(Experimental Breeder Reactor-II (EBR-II) and Fermi-1 Blanket Fuels)
(Reference "H")

Location: Argonne National Laboratory-West (ANL-W); Idaho National Engineering and Environmental Laboratory (INEEL)

Quantity: ~260 kg Pu in 57 metric tons of heavy metal (MTHM) spent nuclear fuel (SNF)

Background: Nearly four decades of DOE research, development, and demonstration for liquid metal fast breeder reactors generated 60 MTHM sodium-bonded SNF. Several available technologies could treat this SNF, including: electrometallurgical treatment (EMT), melt and dilute (for disposal as high-level waste), and a canyon separation process at SRS. While there are several different fuel types, only the EBR-II and Fermi-1 blanket fuels are compatible with SRS canyon processing.

Present Plans/Disposition Baseline: The September 2000 Record of Decision on the Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel states that the EBR-II SNF (blanket and driver fuels), as well as miscellaneous small lots of sodium-bonded SNF, will be dispositioned via the EMT process at ANL-W. The Fermi-1 blanket fuel, due to its different physical characteristics, will be stored while the Melt, Drain, Evacuate, and Calcine option is evaluated. If this latter option proves unattractive, processing of the Fermi-1 fuel via EMT could begin in 2006.

Canyon Options: Fuel must be declad before treatment at SRS, either at SRS or in remote facilities before transfer. The resulting spent fuel (mostly DU with some Pu content) would be dissolved much as production targets were previously processed at SRS, with Pu recovered and stabilized to DOE's Long-Term Storage Standard for disposition and DU converted to oxide for storage or disposal. Either F or H Canyon could be used, requiring approximately 10 dissolver months.

Canyon Impacts: None expected. Viable non-canyon disposition alternatives remain attractive.