External Technical Review of the Plutonium Preparation Project at Savannah River Site

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Dr. David S. Kosson, Vanderbilt University
Dr. David R. Gallay, Logistics Management Institute
Dr. R. Bruce Mathews, Consultant
Mr. David Nulton, National Nuclear Security Administration (ret.)
Dr. Kenneth Okafor, South Carolina State University
Dr. Steven Krahn, U. S. Department of Energy

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Abbreviations and Acronyms

AFS	Alternate Feed Stock
ALARA	As low as reasonably achievable
ARIES	Advanced Recovery and Integrated Extraction System
ATD	Applied Technology Development
CD	Critical Decision
CDR	Conceptual Design Report
CSCC	Container Surveillance and Storage Capability
DFA	Driver Fuel Assemblies
DMO	Direct Metal Oxidation
DOE	US Department of Energy
DSA	Documented Safety Analysis
DWPF	Defense Waste Processing Facility
EM	DOE Office of Environmental Management
EPA	Environmental Protection Agency
FFTF	Fast Flux Test Facility
HAC	H-Area Complex
HRP	Human Reliability Program
HUFP	Hanford Unirridated Fuel Packages
ICD	Interface Control Document
KAC	K-Area Complex
KAMS	K-Area Materials Storage
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LWO	Liquid Waste Organization
MFFF	Mixed Oxide Fuel Fabrication Facility
MOX	Mixed Oxide
NESHAP	National Emission Standards for Hazardous Air Pollutants
NNSA	National Nuclear Security Administration
NPDES	National Pollutant Discharge Elimination System
PDCF	Pit Disassembly and Conversion Facility
PIC	"Person-in-Charge"
PIDAS	Perimeter Intrusion Detection and Assessment System
PuPP	Plutonium Preparation Project
SCDHEC	South Carolina Department of Heath and Environmental Control
SEIS	Supplemental Environmental Impact Statement
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
TMP	Technology Maturation Plan
TRA	Technology Readiness Assessment
TRU	Transuranic Waste
WAPS	Waste Acceptance Product Specifications

Executive Summary

External Technical Review of the Plutonium Preparation Project

The mission of the Plutonium Preparation Project (PuPP) is to prepare for disposition of approximately 12.8 MT of plutonium materials. Of the 12.8 MT of plutonium to be dispositioned, 7.8 MT of weapons usable material will be prepared as feed material for the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF), with 4.1 MT being directly transferred to MFFF and 3.7 MT requiring processing prior to transfer to the MFFF. The remaining up to 5 MT is planned to be processed in H-Canyon (although DOE's processing and disposal plans for this material need to be refined as discussed below). Plutonium-containing liquid waste from H-Canyon is planned to be mixed with existing high level waste and vitrified at the Defense Waste Processing Facility (DWPF) and prepared for transport to the federal geologic repository.

The scope of the proposed preferred alternative includes installing equipment in the K-Area Complex (KAC) in order to prepare the materials for disposition in the MFFF and H-Canyon. The project scope also includes non-destructive and destructive examination, restabilization, disassembly of Fast Flux Test Facility (FFTF) unirradiated fuel, and repackaging capabilities for plutonium stored in 3013 containers. The processing in H-Canyon will be completed by 2019, in time for the planned closure of H-Canyon.

The objective of this review is to verify that the assumptions upon which the PuPP approval decision (revised critical decision (CD) 1A, June 27, 2008) was based are appropriate and reasonable, including that:

- the planning to process the amount and types of material is technically sound;
- all relevant programmatic considerations for proceeding with this processing approach have been identified and are being appropriately addressed; and,
- the cost estimates for the planned project are inclusive and reasonable.

A detailed review of PuPP primary assumptions is provided in this report. The findings and recommendations of this review are:

1. For disposition of up to 5 MT of the plutonium, the assumption that the license application for the planned federal geologic repository at Yucca Mountain can be amended to allow an increased plutonium concentration in the vitrified waste form produced by DWPF is not a valid assumption or acceptable under DOE's approach for the repository. Consequently, alternative disposition paths and/or processing plans for this material need to be developed. In this regard, the associated assumption concerning increased criticality limits for DWPF waste processing tanks may not be necessary.

2. The PuPP has developed an approach to the disposition of the remainder of the 12.8 metric tons of plutonium material that has a sound technical basis, with a limited set of technology challenges to overcome.

3. The proposed PuPP requires an unusually large number of programmatic interfaces and is highly schedule constrained. For example, the PuPP is constrained by the scheduled completion of H-Canyon operations by 2019. Possible delays in overcoming technology development and demonstration requirements, necessary administrative and regulatory requirements, and/or meeting procurement and construction schedules reduce the probability of the project achieving the project goals in the allowed time. The PuPP recognizes these risks; however, the PuPP should rapidly develop detailed plans to mitigate or overcome each of the major risks to project success.

4. The proposed PuPP has established a planning process that is commensurate with the current stage of the project. Project planning includes appropriate consideration of technical and safety requirements, interfaces internal and external to the PuPP, project constraints, project scheduling and cost estimating. Tracking should be maintained throughout the program, along with on-going verification of the validity of key assumptions, using the project risk management system.

5. A high level schedule with necessary logic ties currently is available only for the conceptual design stage of the project. A high level schedule for the entire project should be developed as soon as possible that includes all necessary logic ties: 1) within the PuPP and 2) to critical facility improvements and processes external to the PuPP on which the PuPP is dependent (e.g., H-Canyon upgrades). This will provide early identification and a mechanism for tracking of critical path items and dependencies within and external to the project.

6. Execution of the proposed PuPP requires an unusually large number of interfaces with other projects, facilities and organizations to successfully achieve the mission objectives and schedule. Thus, a high level of coordination is required. The review team is concerned that up to the time of the on-site review only one DOE federal employee was allocated to the project on a full-time basis. A plan is under development for increased federal personnel support to this proposed project, which should be finalized and implemented expeditiously.

7. Most of the technical operations needed for completion of the PuPP are based on demonstrated technologies, with recent experience either at Savannah River Site (SRS) or within the DOE complex. The notable exceptions are:

   <u>Within the Proposed PuPP</u>

   a. The design and operation of the furnace for plutonium metal oxidation, which will require development and demonstration as part of the project's technology maturation plan. The review team is concerned that this is a relatively long-lead time requirement that needs increased early attention to assure timely availability of this critical process step. Currently, Savannah River National Laboratory (SRNL) does not have the facilities necessary to process the quantities of plutonium necessary to demonstrate furnace performance and therefore furnace development and demonstration may need to be carried out at an alternative DOE site. A technology maturation plan for the plutonium metal oxidation process is under development. The PuPP should take advantage of the technology development and lessons learned for the Advanced Recovery and Integrated Extraction System (ARIES) project at Los Alamos National Laboratory (LANL) to the greatest extent practical, and completing the technology maturation plan currently underway as soon as practical, to mitigate technical and schedule risks associated with this processing step.

b. Disassembly of FTFF fuel and test pin assemblies with varying geometries and fuel pin compositions. Expertise is being sought from Hanford personnel involved in the production of FTFF fuel assemblies.

<u>External to the Proposed PuPP</u>

c. The availability of a certified interim plutonium storage container (other than 3013 canisters) and associated closing stations (i.e., crimping) to provide storage and transfer of materials processed at KAC.

d. Verification and acceptance of gadolinium as a poison within the sludge batches (if necessary) should be pursued and must be consistent with the limits of the Yucca Mountain license application.

Each of the above issues is discussed in more detail in this report with additional specific recommendations.

8. The proposed PuPP has several challenges that have the potential to adversely impact timely completion of the mission:

<u>During Construction</u>

a. The availability of a sufficient number and mix of cleared, skilled craft workers during KAC construction activities. The proposed PuPP will be in competition with other projects within and external to SRS, especially as other nuclear construction projects progress. The requirement for security cleared workers for the proposed PuPP will exacerbate this challenge. The proposed PuPP, in coordination with other SRS activities, should develop a plan for insuring the availability of sufficient numbers of security cleared, skilled craft workers.

b. The more than 150 skilled craft workers that are currently estimated to be needed to be working at the same time within the perimeter intrusion detection and assessment system (PIDAS) at KAC during the peak of construction activities. The very limited space where renovation is to occur and the logistics of security controlled ingress and egress from the construction locations will constrain construction efficiency. More detailed planning of construction activities should be carried out with emphasis on reducing the number of workers required to be working concurrently in the space at KAC designated for renovation to support the PuPP.

<u>During Operations</u>

c. The processing of the FFTF fuel is likely to be the rate limiting process within the PuPP Facility. The estimated time of 4.5 years for the completion of the processing of the fuel assemblies is less than the scheduled five years, but does not explicitly consider potential inefficiency in operations due to shift changes or unplanned events. Parallel processing of both the 3013 containers and FFTF fuel will be needed for the proposed PuPP to conclude its mission before the scheduled closure of the H-Canyon. As a result of these considerations, the time and motion study should be re-visited to confirm that the processes in the PuPP Facility will be completed in the assumed five-year period of operation.

d. The anticipated high tempo of plutonium material transfers under necessary security and safeguards during the operational phase of the proposed PuPP. This will be an important consideration in achieving desired overall processing throughput. Coordination with security planning, which should be included as part of time and motion studies, should be an integral and early part of continued project development.

e. Processing delays at facilities beyond proposed PuPP control, including H-Canyon and DWPF. In-process storage surge capacity should be carefully evaluated to mitigate this schedule risk to the extent practical.

9. The safety strategy for the proposed PuPP is consistent with DOE required practices and procedures. Early assumptions regarding strategies to mitigate the potential impacts of a fire scenario in the KAC during plutonium processing are appropriately conservative for the current stage of the project. However, opportunities may exist to reduce the project cost associated with safety systems through subsequent evaluation (e.g., requirement for a safety class active containment ventilation system using sand filtration). The following actions are recommended to clarify this need:

   a. The safety-in-design risk and opportunities assessment report should include a value engineering study that considers alternatives to an active safety class ventilation system, such as controlling combustible loading or upgrading the fire suppression system.

   b. DOE-SR should review the 3013 container integrity analysis carried out by LANL and then if needed, should recommend to the Material Identification and Surveillance Working Group (at LANL) the development and implementation of a program to fire test 3013 containers to provide a more accurate bounding fire safety analysis. Development of the test plan will require buy-in from all parties responsible for acceptance of the test results.

10. The project cost estimates have followed generally accepted procedures and are appropriately thorough for the current stage of the project. The following are recommendations for improved estimates:

   a. Use more current forecasts of escalation rates and apply more sophisticated modeling techniques to estimate the effects of escalation.

   b. The next update to the schedule and cost risk estimates should be based on application of probabilistic risk analysis techniques.

External Technical Review of the Plutonium Preparation Project

1. Background

As part of the Department's overall program to dispose of surplus plutonium, the Deputy Secretary approved on September 6, 2005 the Mission Need, Critical Decision-0 (CD-0) for the disposition of approximately 12.8 MT[1] of surplus weapons-usable plutonium materials (previously planned for immobilization) that might not be suitable as feed material for the MFFF which is intended to process at least 34 metric tons of surplus, weapons-usable plutonium. On August 17, 2006, the Deputy Secretary approved the selection of small-scale vitrification for treating the 12.8 MT plutonium materials prior to disposal as the Preferred Alternative (CD-1A) and a cost range of $300-$500 million.

In April 2007, the Department published the Business Case for the proposed baseline approach for disposing of surplus plutonium. The baseline approach to accomplish these objectives involved the following:

1. Design, construct, and operate a small-scale plutonium vitrification process in basement level of the K-Reactor Building to vitrify up to 12.8 metric tons of non-pit plutonium with high-level waste.

2. Operate the existing H-Canyon/HB-Line facilities to process approximately 2 metric tons of plutonium-bearing materials (of the 12.8 metric tons to be vitrified) concurrent with the recovery of enriched uranium for subsequent down-blending to low enriched uranium and sale.

3. Construct and operate a MFFF, a Pit Disassembly and Conversion Facility (PCDF), and a Waste Solidification Building to dispose of at least 34 metric tons of weapons-grade plutonium.

As the conceptual design of the plutonium vitrification project progressed, the project cost estimate significantly exceeded the CD-1A cost range, and the plutonium disposition project team initiated evaluation of other options to meet the mission need to disposition the 12.8 MT of plutonium, leading to a revised CD-1A decision.

To support development of the revised CD-1A for the Plutonium Preparation Project (PuPP; earlier named the Plutonium Disposition Project when small-scale vitrification was part of the preferred alternative), the DOE Office of Environmental Management (EM) completed a revised alternatives analysis evaluating several new approaches and integrating the missions of the National Nuclear Security Administration (NNSA) and EM, as well as the life cycles of

[1] Subsequently, of the 12.8 MT plutonium indicated here, it has been determined that approximately 4.1 MT is suitable and 3.7 MT of metal may be suitable after oxidation as feed for MFFF.

proposed and existing facility assets at SRS. As a result of the completed analysis, a revised (current) preferred approach was identified that eliminated small-scale vitrification and expanded the use of existing facilities.

The current preferred proposed approach for disposition of the 12.8 MT of plutonium involves 7.8 MT of weapons grade material to be prepared as feed for the MFFF and the remaining 5 MT to be processed in H-Canyon (increased from 2 MT in the earlier baseline approach that included small-scale vitrification), eliminating the need for small-scale plutonium vitrification. The scope of the preferred approach includes installing equipment in the KAC to prepare the materials for disposition in the MFFF and H-Canyon. The project scope also includes non-destructive and destructive examination, restabilization, disassembly of the FFTF unirradiated fuel, and repackaging capabilities for plutonium stored in 3013 containers. The processing in H-Canyon will be completed by 2019 in time for the planned closure of H-Canyon.

The current proposed approach is shown schematically in Figure 1. The primary disposition pathways for the 12.8 MT plutonium following receipt at KAC are (i) transfer to MFFF plutonium oxide suitable for use in fabricating MOX fuel for commercial reactors, (ii) conversion of plutonium metal suitable for use in MOX fuel to plutonium oxide and then transfer to MFFF for MOX fuel fabrication, (iii) transfer of plutonium metal and oxides not suitable for MOX fuel to H-Canyon for dissolution and then transfer of the resulting plutonium stream to be mixed with high-level waste and vitrified at DWPF, for ultimate disposal in a planned geologic repository (assumed to be Yucca Mountain), in accordance with acceptance criteria for the planned repository.

Revised Plutonium Disposition Strategy

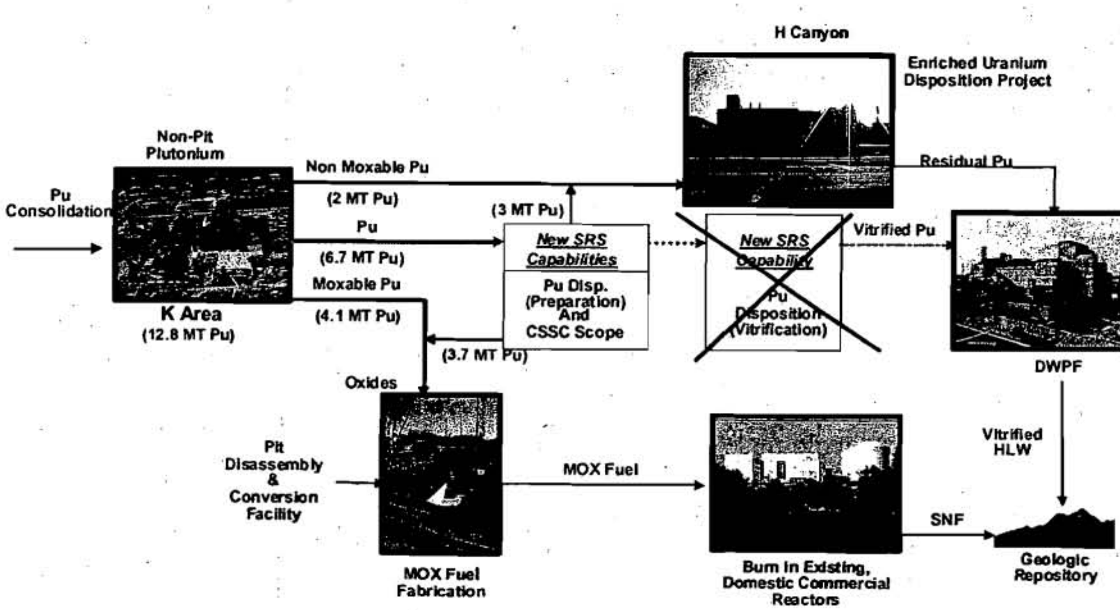

Figure 1. Plutonium disposition strategy.

In November 2007, an Independent Project Review (IPR) was completed on the preferred approach, and in December 2007, a panel of recognized experts external to DOE was commissioned to review the IPR results. The expert panel endorsed the proposed recommendation that eliminated the small-scale plutonium vitrification process and instead processed the material through H-Canyon and MFFF.

The cost range for the currently recommended alternative is \$340-\$540 million, and in accordance with DOE Order 413.3A, the Critical Decision approval authority is the Under Secretary. On June 27, 2008 the Under Secretary approved the revised preferred alternative CD-1A and directed that an additional technical review be conducted to verify the technical, programmatic and cost assumptions of the PuPP. This report provides the requested review.

2. Review Scope

The objective of this review was to verify that the assumptions upon which the PuPP approval decision (revised critical decision (CD) 1A, June 27, 2008) was based are appropriate and reasonable, including that:

- the planning to process the amount and types of material is technically sound;
- all relevant programmatic considerations for proceeding with this processing approach have been identified and are being appropriately addressed; and,
- the cost estimates for the planned project are inclusive and reasonable.

The scope of the review is bounded as follows:

<u>Technical</u> - all technical aspects of the PuPP, including the interfaces with, and project-specific activities within, DWPF and MFFF, are included in the review scope. Direct consequences of executing this project, such as the need for and ability to process the waste resulting from this project, are also included in the scope of the review.

<u>Programmatic</u> - the degree to which the project planning incorporates known or likely developments, including externalities, that directly bear on the ability of the project to successfully accomplish its mission are included in the scope of the review. This includes the project's ability to accommodate delays in the expected availability of interfacing facilities. Alternatives to processing this material other than at Savannah River are outside the scope of this review.

<u>Cost</u> - the process used for developing the cost estimate, whether all project-related costs have been included, and the reasonableness of any assumptions used in developing the cost estimate are included in the scope of the review.

Lines of inquiry, listed below and categorized as either technical, safety, programmatic, schedule or cost, were developed by the review team to aid in discerning underlying PuPP assumptions and assist in guiding the review inquiry:

Technical

1. Does the PuPP process flow plan provide complete disposition pathways for all of the plutonium included in the PuPP, from receipt through ultimate disposition?
2. What are the technical readiness levels and technology maturation requirements for each unit operation planned for the PuPP?
3. What modifications to facilities (KAC, H-Canyon, MFFF) and facility interfaces are required to execute the PuPP? Are the modifications considered major or minor?

Safety

4. What is the Safety Design Strategy (DOE-STD-1189) for the project and project components (i.e., KAC and H-Canyon upgrades)?

Programmatic

5. What is the current state of planning, organization and resource allocations to implement the Project?
6. What is the status of responses to the recommendations made by prior reviews?
7. What are the regulatory requirements and the permitting/licensing strategy for the project (e.g., for processing extra plutonium in MFFF)?
8. How will the important interfaces between facilities and functions (receipt and inspection, analytical support, waste transfer lines, tank farms, etc), be managed?
9. What are the Project impacts on waste management facilities and programs at SRS?

Schedule and Cost

10. What are the critical schedule, facilities and resource constraints that may impact timely completion of the Project?
11. What are the bases for schedule and cost estimates (capital and operations) for the Project?

The above scope and approach was reviewed with the Principal Deputy Assistant Secretary (EM-2) and the Manager of DOE-SR, prior to commencing this review.

3. Definition of the Plutonium Disposition Program and Plutonium Preparation Project

Figure 2 provides a conceptual level schematic diagram of the plutonium material flow for the Plutonium Disposition Program. The PuPP is the sub-component of the Plutonium Disposition Program responsible for receiving plutonium from storage within the KAC, converting plutonium metal to plutonium oxide, evaluating plutonium composition, disassembling FFTF fuel for H-Canyon processing, and then packaging the resultant materials for transfer to the next step in the disposition process. PuPP includes construction of the PuPP Facility within KAC and construction of necessary upgrades to the SRNL and F/H Canyon analytical laboratories.

Plutonium materials with reliable composition analysis, not requiring conversion from metal to oxide, and suitably packaged will be transferred directly from storage vaults at KAC to either MFFF or H-Canyon for processing without additional sampling or processing at the PuPP Facility. The Plutonium Disposition Program, including the PuPP, are dependent on other SRS facilities to accomplish its mission, including H-Canyon, MFFF (managed by NNSA) and the High Level Liquid Waste Operations (LWO) facilities, primarily sludge batch feed tanks, DWPF and to a lesser extent the Salt Waste Processing Facility and Saltstone Preparation Facility.

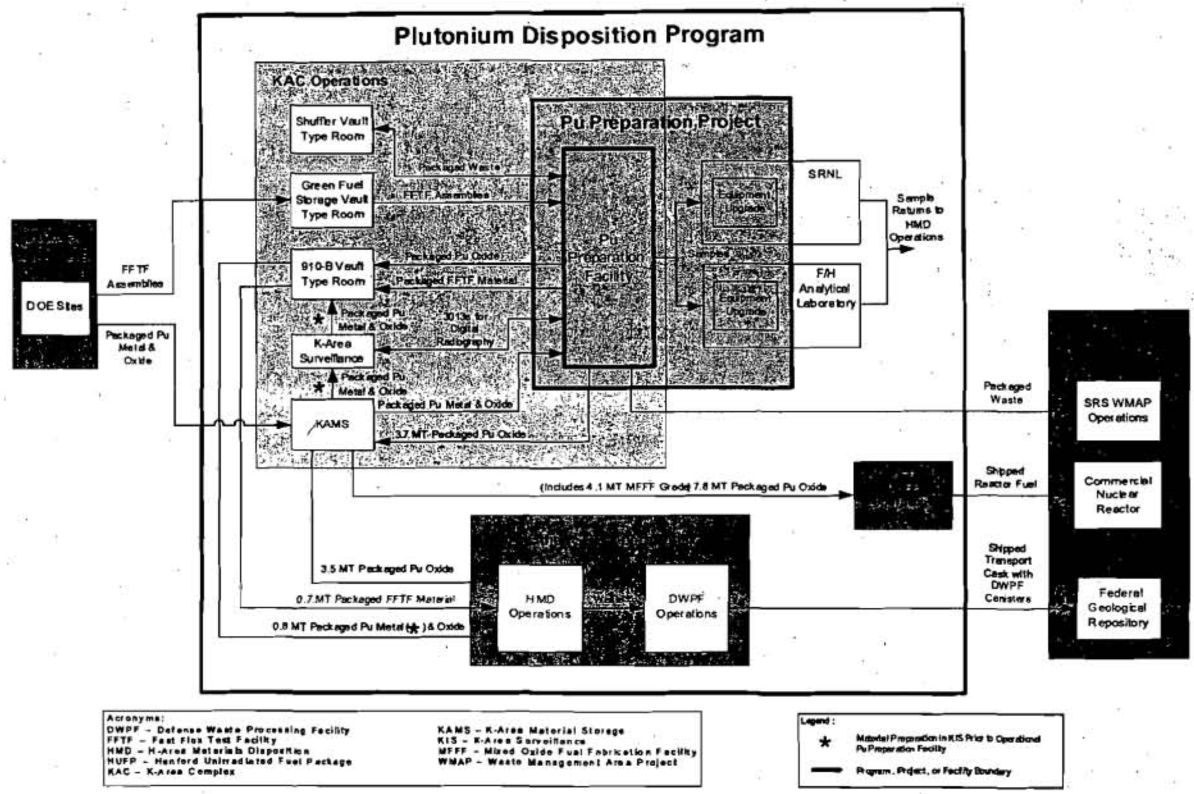

Figure 2. Conceptual flow diagram of plutonium material for the PuPP.

12.8 MT of plutonium will be handled by PuPP:

- 12.1 MT is in metal and oxide forms packaged in 3013 containers and will originate from Hanford, Los Alamos, Livermore, Rocky Flats, and Savannah River sites;
- 0.7 MT plutonium in FFTF driver fuel assemblies (DFAs) and test rods will originate from Hanford.

The 12.8 MT of plutonium will be distributed after preparation by the PuPP Facility to the designated interfacing facilities as follows:

- 7.8 MT of packaged plutonium oxide (4.1 MT of MFFF-Grade from K-Area Materials Storage (KAMS) and 3.7 MT of MFFF-Grade oxide produced from metal) will be shipped to the MFFF.
- 3.5 MT of packaged non-MFFF-Grade plutonium oxide from KAMS will be shipped to H-Area for dissolution and further processing.

- 0.8 MT of packaged non-MFFF-Grade plutonium metal and oxide from the 910-B Vault will be shipped to H-Area for dissolution and further processing.
- 0.7 MT of packaged FFTF material will be shipped to H-Area for dissolution and further processing.

The unit operations and required processing equipment within the PuPP Facility and associated supporting facilities within KAC are illustrated in Figure 3. Material handling and processing within KAC includes receipt of 3013 containers, unpacking and examination of material, oxidation of plutonium metal and re-stabilization, and repacking of material into interim containers for on-site shipping to H-Canyon or repackaging into 3013 containers for shipment to MFFF. The FFTF fuel rods will be de-clad and fuel pellets repackaged for on-site shipment to H-Canyon. All of the processing steps that are to be carried out in the PuPP Facility, except for plutonium metal oxidation, are straightforward mechanical operations, most of which have been used throughout the DOE Complex.

Processing steps in the supporting facilities including KAMS, H-Canyon, MFFF, LWO, and DWPF are well established, but some modifications to the non-MFFF processing conditions and final waste forms will be needed as discussed in the following sections.

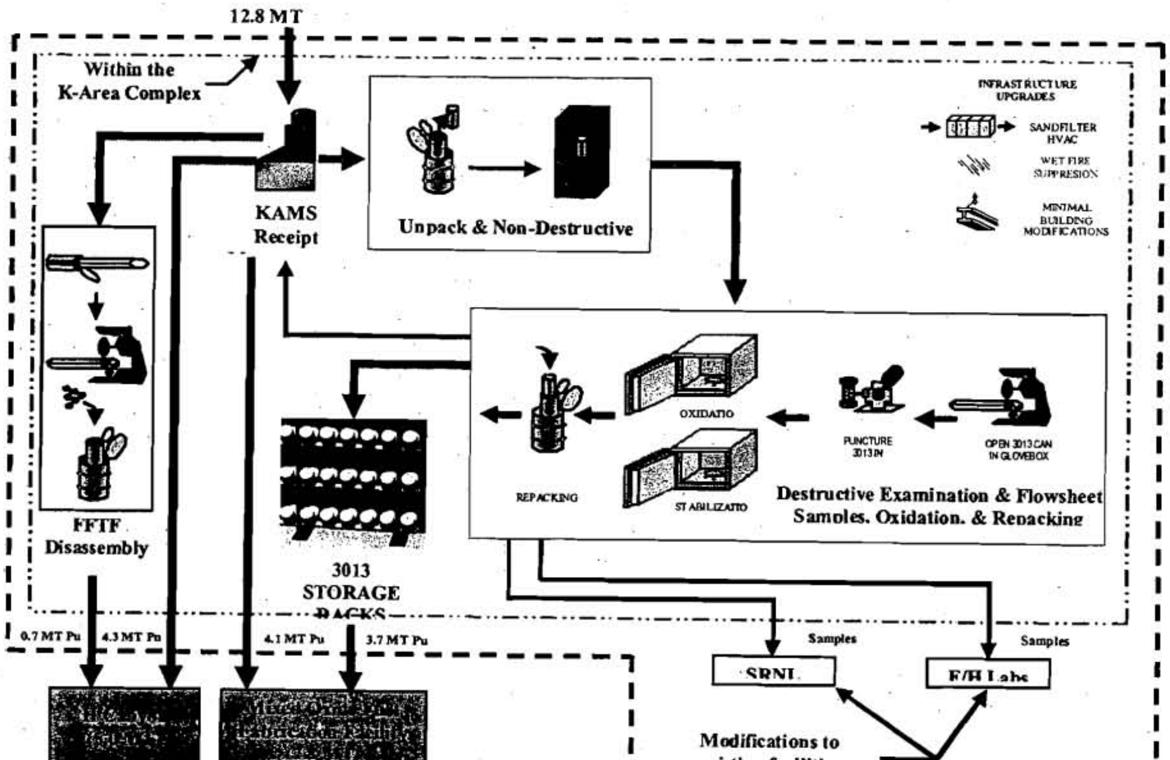

Figure 3. Plutonium preparation operations in KAC.

4. Evaluation of Technical Basis and Assumptions

Technical Assumptions

The following are the primary technical assumptions inherent in the PuPP:

T-1. Flowsheet and throughput rate validation, equipment testing, and development to demonstrate technical maturity of all H-Canyon and KAC unit operations will be completed before going into production.

a. Flowsheet throughput rates for H-Canyon and KAC operations will support the 2019 completion date of processing by H-Canyon.
b. A metal oxidation furnace will be developed from a commercial heat-treating furnace assuming the need for full scale hot testing.
c. FFTF fuel pin disassembly and pellet removal procedures in KAC will consider all known fuel types and forms and will be relatively straightforward.
d. FFTF sintered pellet dissolution in H-Canyon can be based on past dissolution studies with minor flowsheet development during disposition operations.

T-2. Although not a valid assumption that is consistent with DOE's approach concerning the planned federal geologic repository for high level waste and spent nuclear fuel, the PuPP assumes that fissile material concentration limits for the DWPF waste processing tanks will be increased to accommodate the up to 5MT of plutonium to be processed through H-Canyon.

a. The extra plutonium from KAC remains homogenously distributed in solution in the H-Canyon solution tank and the sludge batch tanks (feed for DWPF) in order to maintain criticality control.
b. The added gadolinium will be homogenously distributed throughout the contents of the tanks and credited for criticality control in the H-Canyon solution tank and sludge batch tanks.
c. The increased amount of plutonium and added gadolinium poison going into the DWPF melter do not negatively impact DWPF operations and vitrified waste glass quality.

T-3. A package compliant to the new DOE packaging Manual, DOE M441.1-1, to support on-site transfers between KAC and HAC and MFFF will be available to meet the PuPP schedule.

Technical Maturity

Technology Readiness Assessment/Technology Maturation Plan: DOE-EM published the Technology Readiness Assessment (TRA) / Technology Maturation Plan (TMP) Process Guide (2008) to provide a methodology for evaluating technical maturity of processes and technologies and defining the necessary steps for technology maturation consistent with project schedules. While the TRA/TMP process is not currently required by DOE Order 413.3A, the TRA/TMP process is an effective tool to help meet the Critical Decision schedules required by DOE Order 413.3A. According to the guide, a Technology Requirements Review should be performed at CD-0 to assess the adequacy of requirements definition and characterization information, and to determine if any technology development is needed prior to implementation. Prior to CD-1 approval, all critical technologies that support PuPP design should be based on small scale tests using prototypic material. In addition, a plan that details the strategies for testing these technologies at a pilot scale in a relevant environment should be prepared. The PuPP has not formally implemented the TRA/TMP process; however, technology maturity was briefly discussed in the Technical Overview presentation at the August 11 – 14, 2008 Independent Technical Review Meeting. With the exception of the direct metal oxidization step, the PuPP team estimates that PuPP Facility unit operations have been qualified to sufficient technical maturity to facilitate implementation (Carey, 2008). It is suggested that the PuPP team follow the TRA/TMP process, evaluate the technical readiness levels of each unit operation, prepare technology maturation plans where needed and integrate these measures into the Critical Decisions schedules.

Material Flows: The most notable aspect of the PuPP, and potentially the most vulnerable, is the number of facility interfaces and nuclear material transfers that will be required to prepare the incoming plutonium for disposition. While the conceptual flow plan for plutonium has been developed by the PuPP team, detailed flow sheets that account for material processing at each operation, including material losses, chemical changes, waste streams, etc., have not been developed and assembled into an integrated material flow sheet.

The primary objective of sorting the 3013 canister inventory of plutonium materials to be processed is to maximize the quantity of plutonium that could be proposed to be used by MFFF to produce mixed oxide fuel. Plutonium metal that had acceptable composition for MFFF use would be converted to plutonium oxide at the PuPP Facility (located within KAC) prior to re-packaging and transfer to MFFF. Plutonium oxide (including plutonium metal converted to oxide) not suitable for use by MFFF would be dissolved at H-Canyon (H- and HB lines). Evaluation of the 3013 canister inventory for suitability to be processed by MFFF included consideration of plutonium content in each canister, ionic impurities (e.g., chlorides and fluorides), actinide impurities, and the content of Be, ^{241}Pu, ^{241}Am (a daughter that is a gamma emitter) and ^{248}Pu because of their contributions to operator dose. Each unit operation at MFFF was considered as part of the screening (Spiteri, 2007).

Processing Steps: Based on the presentations, available documents, and individual experience of the Independent Technical Review members, the following four processing steps could be identified as critical technology elements under the TRA/TMP process[2] and appear to require additional development and testing.

1. **Direct Metal Oxidation (DMO)**. The oxidation of plutonium metal is a relatively well defined exothermic chemical process. The uncontrolled oxidation of solid plutonium metal ingots in air is analogous to a burning charcoal briquette. Temperature under the resultant oxide coating will increase until the plutonium core is molten (Felt, 1967). Oxidation in

[2] A technology element is "critical" if the systems being acquired depend on the technology element to meet operational requirements (with acceptable development cost, and schedule and with acceptable production and operations costs) and if the technology element or its application is either new or novel (DOE TRA/TMP Process Guide, pg. 24).

the DMO furnace will be a controlled process and will require careful monitoring of the furnace temperature and furnace gas feed composition to ensure sufficient oxidation without transforming the unoxidized plutonium to a molten state. The rotating DMO furnace planned for this project is a complex piece of equipment that has not been demonstrated, and must be scaled down from a commercial unit used for non-radioactive operations.

A DMO furnace is under development and is currently being demonstrated by Los Alamos National Laboratory (LANL) for use in the Pit Disassembly and Conversion Facility (LANL 2008). The LANL DMO furnace is designed to produce an oxide product that meets the DOE-STD-3013 requirements and consists of controlled atmosphere - rotating basket DMO furnace section and a close coupled screw calciner capable of 950C calcination. The PuPP DMO unit does not need to produce a product that meets DOE-STD-3013 requirements and does not have an integral calciner. Feedstock in the LANL DMO furnace will be primarily hemishells whereas the PuPP's DMO furnace feed will be primarily buttons and ingots. A second-generation LANL DMO test unit has operated with plutonium on multiple cycles and a third generation test unit is available for cold testing. Although different in design, some transfer of technology could occur, such as process control strategy and parameters, oxide handling interfaces, etc.

Overall Assessment: A technology deployment plan (G-TDP-K-00002, *Technology Integration Plan*, May 12, 2008) has been prepared but lacks specificity with regard to the need for full-scale hot testing of the DMO furnace. Full-scale hot demonstration testing of the DMO furnace should be performed as part of the technology maturation process. It appears that SRNL lacks the ability to receive plutonium in sufficient quantity to perform these hot tests and therefore an alternate location for full-scale hot testing needs to be identified. Development of process control parameters, adaptation for glovebox operation and maintenance, and development of feed and product interfaces also must be accomplished. The compressed schedule for the PuPP suggests it is important to expedite the DMO furnace development, using prototypic equipment and processes. Cold testing can be accomplished on-site with emphasis on scale-down from commercial equipment sized for other applications and adaptation to a glovebox operation. The PuPP should take advantage of the technology development and lessons learned for the ARIES project at LANL to the greatest extent practical to mitigate technical and schedule risks associated with this processing step. The PuPP should include evaluation of the potential to directly adopt or adapt the LANL design.

2. FFTF Fuel Disassembly, Download of Pellets, and Pellet Dissolution. Unirradiated fuel to be processed in the PuPP Facility is in the form of complete DFAs and individual fuel pins packaged in IDENT-69 pins containers. DFAs and IDENTS are packaged into overpacks called core component containers that are shipped and stored in Hanford Unirradiated Fuel Packages (HUFPs). The loaded HUFPs, each approximately 14,000 lbs gross weight, will be moved into a new area constructed for fuel disassembly and processing in the PuPP Facility. The HUFPs and core component containers will be opened and then the DFAs and IDENT containers will be extracted in the horizontal position, using an overhead crane. The DFAs or pins will be transferred into a long, open faced hood. The DFA duct will be cut off using a band saw and removed. The pins will be manually transferred into an adjacent glovebox using a transfer port. Once inside the glovebox, both ends of the pins will be cut off using another small band saw and pellets will be pushed out into a collection vessel. When sufficient pellets have been collected to make a charge can, the charge can will be removed from the glovebox, packaged into a container compliant to the DOE M 441.1-1 (DOE 2008), and placed in the new interim vault awaiting packaging for transport to the H-Area for dissolution.[3]

Sintered FFTF pellets will be dissolved at H-Canyon in nitric acid solution tanks. Relevant studies documenting DOE experience with fuel dissolution are available (Lerch 1979, Rainey 1965, Fellows 1986). H-Canyon staff are using the experience documented in Lerch 1979 to establish feasibility, and the project intends to verify the flowsheet with samples of actual downloaded material.

Overall Assessment: The basic approach proposed for disassembly seems workable. However a greater emphasis needs to be put on understanding the fuel pin inventory, with emphasis on the test pins. A greater diversity of form, diameter, pin length and enrichment, hardware and fuel forms, including metal, carbide, and nitride fuels, is likely to be present in test pins than is currently acknowledged. Because the PuPP has no experience in FFTF fuel fabrication or disassembly, the project should sponsor workshops with Hanford personnel experienced in fuel fabrication and disassembly. Input and feedback on disassembly plans and equipment will develop a better understanding of the expected processing rates and hazards present for the disassembly operation.

Packaging of the fuel in the Hanford Unirradiated Fuel Package (HUFP) will not lend itself to early extraction of a few pins for pilot testing of disassembly or pellet dissolution concepts. However, previously downloaded FFTF pellets are present in the 3013 inventory from Hanford. The PuPP should locate these FFTF fuel pellets for demonstration of the planned dissolution flowsheets.

3. Gadolinium Poisoning to Allow Higher Plutonium Loadings[4]: DWPF receives liquid radioactive waste from H-Area and processes that material into glass canisters. The canisters of vitrified material must be consistent with the license application and associated

[3] DOE M 441.1-1 is the Nuclear Material Packaging Manual. It was recently issued in 2008 and provides detailed packaging requirements for protecting workers from exposure to nuclear materials stored outside of an approved engineered contamination barrier. It is focused on short-term storage and not intended to replace the long term storage standard for plutonium bearing material, the DOE-STD-3013. A site implementation plan has been prepared (SRS, 2008) and includes; design, testing and procurement of new compliant containers, development of the technical and safety bases documentation, and repackaging and surveillance activities.

[4] The discussion in this section is presented based upon the proposed PuPP plans as shared with the ETR Team in during the on-site portion of the review and associated PuPP documents shared with the Team. Consequently, although the addition of gadolinium to the sludge batches is not necessary under the constraint of plutonium loading contained in the license application for federal geologic repository at Yucca Mountain, this section presents the ETR Team's comments on those original plans. This is being done to ensure that the PuPP personnel take the ETR Team's comments into consideration to ensure completeness of any future criticality analyses and test plans involving weapons grade plutonium.

analysis for the federal geological repository for high level waste and spent nuclear fuel, which is planned to receive the glass canisters. DOE-EM WAPS regulate the quantities of fissile materials in the canisters.

The proposed PuPP is assumed to have minimal impact on the SRS liquid waste system, specifically no more than 40 additional DWPF canisters and only a 6 month extension on operating life (Bell 2008a). In order for the proposed PuPP to meet this assumption, plutonium loading in the H-Area sludge tank and the DWPF process will have to be increased from the current practice of 80-120 kg Pu/sludge batch up to 600 kg Pu/sludge batch. The resulting plutonium content in DWPF canisters would have to be increased to 5.4 kg Pu/m^3 for PuPP materials (assuming the processing of 200 canisters/year). This would require a change to the DOE-EM WAPS and, more importantly, an increase in the federal geologic repository license application. However, the assumption that the license application for federal geologic repository at Yucca Mountain can be amended to allow an increased plutonium concentration in the vitrified waste form (for disposition of up to 5 MT of the plutonium) produced by DWPF is not acceptable under DOE plans.

Although no longer necessary in light of the above need to limit the plutonium concentration to that stated in the license application, gadolinium poisoning was proposed for criticality control for the sludge batches that feed the DWPF because more preferred mass or geometry controls are not possible. In addition, the ability to achieve homogeneity of gadolinium in the glass material is not known, and would need to be demonstrated.

Management of plutonium in waste vessels can be problematic. Although not directly related to the SRS plutonium disposition plans, it is useful to recognize that Hanford experienced a criticality safety issue with plutonium in the waste tanks in the early 1990's. Only 500 kg plutonium is present in the entire Hanford tank inventory of over one hundred tanks (Brazel 1996). Part of a larger tank safety issue, resolution took years with focus from the DNFSB (Recommendation 93-5, *Tank Waste Characterization*), a new NEPA analysis (DOE 1994), and an extensive tank sampling, characterization and analysis program, in which over 1000 tank samples were pulled. Closure of the issue at Hanford took years.

For the proposed PuPP, schedule constraints drive for resolution of this issue in a timely manner. SRNS-RP-2008-00156 *Tank 12 Characterization and Aluminum Dissolution Demonstration, 9/04/08* describes a planned experiment whereby additional plutonium and gadolinium will be added to the sludge, and the solubility/separation of plutonium and gadolinium, and downstream DWPF process impacts will be evaluated. However, this plan does not address: the acceptability of the increased plutonium content in the processing system and vitrified waste form; increased alpha activity from the fuels and reactor grade plutonium; nor the gadolinium in DWPF operations.

In a recently developed Project Execution Plan, the project clearly acknowledges the significance of these issues. The Draft Project Execution Plan does speak well to the significance of technical issues and the comprehensiveness of the identified scope for resolution. However, the plutonium considered for processing at H-Area is also primarily high burn up plutonium (fuel and reactor grade), with higher specific activity than weapons grade plutonium. Development of final test plans should consider the potential importance of the following:

- Radiolysis hydrogen production in the Tank Farm and the DWPF
- Neutron dose rate from the glass
- Alpha radiation effects on the glasses.
- Wattage (heat load) per canister of glass produced

Overall Assessment: PuPP's proposed processing of the H-Canyon wastes would result in canisters of vitrified waste which are not consistent with the federal geologic repository license application. Therefore, the project needs to reevaluate the disposition pathway for plutonium material currently planned to be processed through H-Canyon followed by vitrification at DWPF, and develop an alternate processing and disposal path for this material.

In light of the above, gadolinium poisoning may not be necessary for an alternate processing and disposal pathway. If gadolinium poisoning remains part of the revised disposition plan, it will be vital to ensure that plutonium stays homogenously diluted by the gadolinium and other absorbers throughout the processing steps and chemical variations. It will also be necessary to show that the plutonium and gadolinium levels do not negatively affect final glass quality. Because this material is primarily high burn-up plutonium, with alpha activity as much as ten times that of weapons grade plutonium, consideration must be given to the effect of the increased alpha dose as well. The proposed PuPP will need a detailed technical maturity plan to verify that the plutonium will be homogeneously distributed and that criticality can be controlled with gadolinium[5]. Accordingly, if this strategy is pursued, it is recommended that the PuPP, in collaboration with the H-Area personnel:

- Pursue hot testing to ensure that the plutonium stays homogeneously distributed though all needed waste processing steps (e.g., caustic wash, acidification, Hg removal, etc.).
- Validate that the use of gadolinium is a suitable neutron poison or that an alternative poison is acceptable for achieving necessary plutonium loadings during processing.
- Carry out an independent technical review of the chemistry and criticality analysis of planned processing using experienced national laboratory personnel.
- Perform a sensitively analysis to determine if the disposition plans remain feasible at the levels determined to be appropriate for waste loading of plutonium.

4. Development of Interim Packaging: The PuPP will utilize a yet-to-be developed re-usable container for interim storage of material in the new KAC storage racks, for transfer of material from KAC to H-Area (within Type B packaging), and for handling in H-Area as part of preparation for dissolution. This container will be compliant with DOE M

[5] See the above footnote.

441.1-1 *Nuclear Material Packaging Manual*. Storage in KAC is expected to be brief in duration, and meeting the DOE-STD-3013 is unnecessary for material to be dispositioned in H-Area. The DOE–STD-3013 containers are more substantial, single-use, and suitable for long-term storage up to 50 years. They utilize multiple barriers, welded, leak testable containment and a robust outer package. Packaging capability to produce DOE-STD-3013 containers will still be required in KAC to allow transfer of material to the MFFF in accordance with existing interface agreements.

A draft site implementation plan for DOE Manual 441.1-1 has been developed (SRS, 2008). The plan includes $2.7 million and 18 months to design, test, and procure new compliant packages. Implementation of the manual is a site-wide programmatic activity not specifically tied to the PuPP. However the PuPP has assumed the use of a "developed" compliant package.

Overall Assessment: The development of the interim package needs to proceed. The effort should be integrated with the PuPP schedule. Sufficient definition of the package design will be required to allow the PuPP vault and equipment design to be completed. In addition, an opportunity may exist to reduce project costs if the MFFF would accept this re-usable interim package for material packaged at the PuPP Facility.

Material Processing Rates: The KAC PuPP Facility will have five years to process 12.8 MT of plutonium; 500-3013 containers and 16,277 FFTF fuel pins will be processed through the PuPP Facility starting in 2014. An estimate of the time needed to process the 12.8 MT of plutonium is developed in M&O-PUD-2008-00024, *Preliminary Assumption List for PuP Time and Motion Study*. Operations of the PuPP are assumed to be 24 hours a day, seven days a week except for downtime for meeting nuclear material accountability requirements. The total time for the receipt and testing of 500-3013 containers is 500 days [i.e., (1-day/container) x (500 containers)]. The total time necessary for the complete processing of 500-3013 containers is 600 days [i.e., (1.2 days per 3013 container) x (500 containers)]. Therefore, the time necessary to serially process all 3013 containers is 1100 days (i.e., 500+600) or approximately three years, which is less than the scheduled five years. Estimated throughput and processing rates seem reasonable, and if some of the processing is done in parallel, the estimated time for processing 3013 containers will be less than three years.

A total of 16,277 (17,000 pins are assumed for conservatism) FFTF fuel pins[6] will be processed in the PuPP Facility. According to the *PuP Time and Motion Study*, 14 fuel pins will be processed at a time in the fuel pin disassembly glove-box. Therefore, the number of cycles needed to complete a cycle of processing of the pins is 1215 days (17,000 pins/14 pins/cycle). It takes 1.35 days to complete a cycle of processing (of pins), so the estimated time to complete the DFA/IDENT69 assemblies is about 4.5 years (1.35 days/cycle *1215 cycles).

From the estimation above, it can be observed that the processing of the FFTF fuel is the rate limiting process in the PuPP Facility. However, the estimated time of 4.5 years for the completion of the processing of the fuel assemblies is less than the scheduled five years.

[6] 12,152 from Driver Fuel Assemblies (DFS) (56 DFAs*217 pins/DFA) and 4125 test fuel pins from the test fuel canisters called IDENT69s (21 IDENT69s * 196.4 pins/IDENT69)

Therefore, if both the 3013 containers and FFTF fuel rods can be processed in parallel, the PuPP will be able to conclude its mission before the mandated closure of the H-Canyon.

Overall Assessment: Estimated throughput and processing rates seem reasonable, but do not explicitly consider the potential inefficiency in operations due to shift changes or unplanned events. Based on the above estimates, the two types of incoming plutonium (3013 containers and FFTF fuel) cannot be processed serially since the total period of operation would exceed the mandated five-year operation of the PuPP, and therefore parallel processing of 3013 containers and FFTF fuel will be required. As a result of these considerations, the time and motion study should be re-visited to confirm that the processes in the PuPP Facility will be completed in the assumed five-year period of operation and that the operations profile permits parallel processing of 3013 canisters and FFTF fuel pins.

5. Evaluation of the Safety Basis, Strategy and Assumptions

Safety Basis Assumptions

The following are the primary safety basis assumptions inherent in the PuPP:

S-1. DOE-STD-1189, Integration of Safety into the Design Process, will be applied.

   a. An active Safety Class, PC-3 exhaust ventilation system and fire detection and alarm will be required in KAC for all of the PuPP facilities, including the new interim storage vault (excluding KAMS where 3013/9975 canister storage occurs).

   b. Operator exposure can be controlled up to a limit of 1000 mr/year with modest shielding and without remote handling.

Safety Design Strategy

The PuPP will follow the design safety guidance in DOE-STD-1189, *Integration of Safety into the Design Process* in support of the equipment to be installed and operated in the KAC and supporting F/H and SRNL Analytical Laboratories. In addition, the PuPP and the H-Area modifications programs have considered and described all required facility upgrades consistent with DOE-STD-1189. The MFFF must be licensed by the NRC in accordance with applicable safety requirements.

Based on presentations and conversations during the August 11 – 14, 2008 Independent Technical Review Meeting, it is clear that the project management team is committed to the basic Safety-in-Design precepts in DOE-STD-1189. The PuPP Plan has considered Safety Design Guiding Principles, and early project decisions have been conservative. The PuPP is at the pre-conceptual design phase, and DOE-STD-1189 describes a number of safety-related requirements that need to be initiated or considered during pre-conceptual design, including:

- Safety Design Integration Team;
- Preliminary inventory of hazardous materials;
- Scoping analysis of potential hazards;

- Primary facility-level design basis accidents;
- Major fire scenarios;
- Criticality potential;
- Containment strategy;
- Seismic categorization;
- Preliminary hazard categorization of the facility;
- Initial determination of safety class and safety significant functions;
- Preliminary assessment of the facility/process risks;
- A Safety-in-Design Risk and Opportunity Assessment; and,
- Emergency Preparedness Hazard Survey.

The PuPP will address all of these safety basis requirements as part of the conceptual design process for the KAC upgrades.

Overall Assessment: While the safety strategy activity list and finish dates in the Conceptual Design Report Preparation Schedule provided during the on-site review are consistent with DOE-STD-1189 requirements, the schedule for development of safety documentation is tight. It was difficult to assess implementation of DOE-STD-1189 at the time of this review because a Safety Design Strategy Report was not yet available.

The application of DOE-STD-1189 for the H-Canyon and LWO facility upgrades is not clear, because no supporting documentation was provided. If existing safety analyses already bound the expected material increases from the PuPP, it may not be necessary to apply DOE-STD-1189.[7] However, it is a reasonable assumption that the H-Canyon upgrade project will comply with DOE safety basis directives. The program should evaluate the magnitude of supporting H-Canyon facility modifications according to the major modification evaluation criteria in DOE-STD-1189 and assess both criticality and material at risk hazards based on increased plutonium throughput.

K-Area: The proposed modifications to KAC and subsequent PuPP operations will involve a major modification to the KAC Documented Safety Analysis (DSA). Most of the DOE-STD-1189 pre-conceptual design activities for the PuPP Facility are scheduled in the Safety Design Strategy section of the PuPP Conceptual Design Report Schedule. In addition, potential hazards, major fire scenarios, criticality potential, containment strategy, seismic categorization, a preliminary design basis accident, and the preliminary hazard categorization of the facility have all been identified based on previous hazards analyses for the Container Surveillance and Storage Capability (CSCC) Project. Project decisions are appropriately conservative. For example, an active confinement ventilation system - using a sand filter to confine inadvertent release of radionuclides - has been designated as safety class for preliminary design considerations. Although the presumed design-basis accident is a fire in the storage area and subsequent rupture

[7] The application of DOE-STD-1189 depends of the magnitude of required modifications.

of 3013 containers, the fire suppression system is not planned to be credited for prevention of inadvertent release.

Some planned processes, such as initial steps of FTFF fuel disassembly are planned to be carried out with direct worker handling. Hazards assessments and dose calculations for these operations have not yet been completed. However, the PuPP schedule has identified plans for conducting a radiation dose assessment and installing radiation control equipment in the PuPP Facility that should validate the assumption that worker dose can be maintained below 1000 mrem/year.

Overall Assessment: The PuPP safety design integration team had not been chartered at the time of the on-site visit for this review. As a result, important safety design integration team activities such as the consolidated hazard analysis, inventory of hazardous materials analysis, and facility/ process risk assessments that should form the basis for the safety design strategy had not yet been developed[8]. While the activity list and finish dates for the conceptual design report preparation schedule are consistent with DOE-STD-1189 requirements, the timing of activities is tight. Without a safety design strategy report it is difficult to verify the quality of implementation of DOE-STD-1189 at this time. For a project at the pre-conceptual stage of design, the PuPP schedule for implementing DOE-STD-1189 appears to be a little late because most of the safety documentation is scheduled to be completed in December 2008.

DOE-STD-1189 also requires consideration of the project QA strategy, draft safeguards requirements identification, and environmental protection. While these are not safety-specific requirements, they are part of DOE requirements and are expected to be included in other required materials disposition documents. The QA strategy for the PuPP was not discussed and will be important to manage material receipt and inspection requirements for nuclear materials being shipped from other sites and between facilities (H-Canyon, MFFF, SRNL) at SRS.

The design basis accident appears to assume the potential of breaching up to seven 3013 containers in a facility fire. However, the likelihood of heat-induced breaching of 3013 containers has not been fully tested.

The PuPP is planning to design and build an active, Safety Class, PC-3 exhaust ventilation system based on a sand filter for HAC operations. This is an appropriately conservative safety strategy for the pre-conceptual design phase; however, the necessity of this assumption cannot be verified until a process hazard assessment based on a complete inventory of radioactive Material at Risk is completed. The assumption of a safety class ventilation system appears conservative, and therefore opportunities may exist to reduce project costs through subsequent evaluations. The PuPP has a safety-in-design risk and opportunities process that is actively assessing project risks. According to DOE-STD-1189 "Opportunities refer to the potential opportunities to reduce the costs or improve the schedules as the design matures..." and "A conservative posture at the equipment level can sometimes be found later in design to be unnecessarily conservative and lead to avoidable costs."

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[8] The PuD Mission Need and Justification Report includes a Safety Design Strategy section which is intended to provide the foundation for the PuPP safety design strategy; however, the information presented does not comply with the content suggested in Appendix E, *Safety Design Strategy*, in DOE-STD-1189.

The safety-in-design risk and opportunities assessment report should include a value engineering study that considers alternatives to an active safety class ventilation system, such as controlling combustible loading or upgrading the fire suppression system. Furthermore, DOE-SR should review the 3013 container integrity analysis carried out by LANL and then if needed, should recommend to the Material Identification and Surveillance Working Group (at LANL) the development and implementation of a program to fire test 3013 containers to provide a more accurate bounding fire safety analysis. Development of the test plan will require buy-in from all parties responsible for acceptance of the test results.

The 1000 mrem/year dose rate for operators may be difficult to meet with "hands-on" operations and shielded gloves. Glove box shielding and cross training of operators may be required to ensure worker dose is as low as reasonably achievable (ALARA). The safety design integration team should initiate an ALARA review program to specifically identify potential high radiation processing operations and propose necessary engineered controls.

Supporting Facilities: Process modifications and equipment upgrades to increase plutonium throughput in facilities supporting the PuPP (H-Canyon, HB-line, SRNL, F/H Analytical Laboratory, and the LWO including the DWPF) will be required to execute the PuPP. The report, M&O-PUD-2007-00104, *PuD Mission Need and Justification Report,* summarizes potential impacts from other SRS facilities, and asserts that PuPP material is expected to have minimal impact on existing Documented Safety Analyses. In addition, the extra plutonium from KAC processing is assumed to be bounded by existing safety bases. Facility modifications and related safety basis upgrades for H-Canyon and the LWO facilities will be managed at the facility level as part of the overall site Nuclear Materials Disposition Programs and not through the PuPP. The MFFF is proposed to receive additional plutonium from KAC that will be within existing baseline specifications.

H-Area: While not explicitly a part of this review, upgrades to H-Canyon and H/B Lines are essential to the success of PuPP. The existing credited controls are not expected to change, and it is anticipated that material increases or changes in composition are already bounded by the existing DSA. As discussed in the Technical Maturity Section, criticality control using gadolinium as a poison may be problematic.

The current DSA for H-Canyon was based on an early shutdown. H-Area facility modifications and revision to the DSA are required for H-Canyon, HB-Line, and the LWO to process material from the Enriched Uranium Project and the PuPP. The Enriched Uranium Project includes plans for $66M of processing and life extension upgrades in H-canyon that are funded from the site-operating budget. The planned upgrades include:

- New H canyon annular dissolver;
- New H canyon Bi cell tank;
- HB line south line reactivation/refurbishment;
- HB line chloride wash process;
- Glove box with 3013 can puncture/opening equipment; and,

- HB line distributed control system upgrade.

Overall Assessment: These planned upgrades are likely to be minor modifications to H-Canyon; however, potential additional hazards such as criticality and hydrogen flammability will have to be carefully analyzed and mitigated.

Liquid Waste Organization: H-Tank Farm will prepare sludge batches which is planned to include the plutonium from KAC. The DWPF will vitrify the sludge batches from H-Tank Farm into glass canisters. Vessel vent and purge gas systems may require additional hazards analyses if there is increased plutonium content. The primary impacts to the LWO facilities may include revision to nuclear criticality safety bases to account for possible use of additional neutron poisons such as gadolinium. Neutron shielding, hydrogen generation rates, and glass canister heating limits will also need to be evaluated.

6. Evaluation of Programmatic Basis and Assumptions

The goal of the programmatic portion of the independent PuPP review was to evaluate the project from the perspective how well project planning to date incorporates known or likely elements of the overall plutonium disposition mission at SRS, including externalities that bear directly on the project's ability to successfully fulfill its mission. Given the number of other SRS facilities needed to accomplish the plutonium mission, the coincidental work that is being preformed in those facilities, and the projected shutdown dates for some facilities, the team focused on the PuPP's ability to accommodate delays that could potentially occur in the expected availability of supporting facilities.

The team began their process by pursuing the following programmatic lines of inquiry:

- The current state of planning, organization, and resource allocations needed to implement the Project;
- The status of responses to the recommendations made by prior reviews;
- The regulatory and permitting/licensing strategy for the project;
- How the important interfaces between facilities and functions will be managed (e.g., material receipt, inspection, analytical support, use of waste transfer lines, tank farm, etc); and,
- Project impacts on waste management facilities and other programs at SRS.

These lines of inquiry led to the discussion and evaluation of programmatic assumptions identified by SRS project staff during the independent review. These assumptions were consolidated by the review team and are summarized below. The review team has evaluated the assumptions to determine if all relevant programmatic considerations have been identified and are appropriately addressed.

Programmatic and Schedule Assumptions

The following is a list of the major programmatic and schedule assumptions inherent in the PuPP:

Programmatic Assumptions

P-1. Agreements will be in place between sites, facilities, contractors and other entities (e.g., DOE offices) to provide timely transfer of materials and wastes.

P-2. The Program will be funded to support project and operational schedules. This includes constructing and maintaining PuPP and all of the cited facilities to meet program requirements and to sustain continued operations for the mission duration.

a. HAC processing and life extension upgrades will be funded and completed on time to support plutonium disposition activities at SRS.

b. KAC design, construction and startup activities (including glove box fabrication, furnace testing, etc.) needed to support the PuPP will be funded and completed on time.

c. The MFFF will receive the required funding and meet schedule requirements for construction and startup that will allow receipt of materials from KAC beginning in 2015 and processing of material by 2016.

d. The KAC shuffler will be available for measurement of waste generated by the PuPP.

P-3. The CSCC Project footprint and other KAC space will be sufficient and available as needed for plutonium disposition use.

P-4. All Applied Technology Development work will be performed by SRNL and will likewise receive required funding when needed and be completed on time. (Furnace testing performed at SRNL cannot exceed SRNL limitations on plutonium handling which may require furnace tests with plutonium to be performed elsewhere).

P-5. Design completion targets of up to 15% for Conceptual Design and up to 50% on some specific scopes for Preliminary Design will be used to achieve higher confidence in the CD-2 project baseline and to support early achievement of CD-3A.

P-6. An adequate number of Q cleared workers requiring unescorted access inside the KAC and certification by the Human Reliability Program (HRP) will be available for the latter stages of the project. HRP certified workers will not be needed for the first half of construction and un-cleared workers will be used for work outside the KAC protected area to the maximum extent practicable.

P-7. Adequate coordination and work load leveling can be achieved to make the KAC construction schedule achievable.

P-8. Adequate coordination and availability of security and safeguards personnel will be in place to support program schedule.

P-9. All necessary permits and licenses required for the PuPP mission will be in place when needed to support HAC, KAC, and MFFF startup and operations. Depending on the facility, these include permits and licenses from the NRC, South Carolina Department of Health and Environmental Control (SCDHEC) and EPA.

Schedule Assumptions

Sch-1. H-Canyon

a. Operations will continue through 2019 but not extend beyond that date. This drives the overall program schedule for completion of the PuPP mission.

b. Approximately 1.2 to 1.9 MT of plutonium will be processed through H-Canyon prior to 2014 (driven by security considerations).

Sch-2. LWO will have transfer lines available through 2023 to accommodate sludge batches produced from H-Canyon processing of PuPP materials through 2019.

Sch-3. PuPP Facility

a. Will begin operations in 2014.

b. PuPP will have a 5.25 year operational life.

c. Engineered equipment items, including process gloveboxes, certain laboratory equipment, HEPA filters, and analytical equipment, will require long-lead procurement to meet KAC/PuPP startup schedule (tight schedule makes this a project risk).

d. Process glove boxes are considered engineered equipment and are currently planned to be fabricated on-site. On-site fabrication experience with glove boxes is well documented and cost/schedule implications are known.

Sch-4. The MOX Fuel Fabrication Facility

a. Will begin receipt and storage of KAC material as early as 2015.

b. Will begin operations in September 2016; it will initiate operations using Alternate Feed Stock (AFS) and polished/unpolished plutonium oxide from ARIES process at LANL.

c. Material from KAC will be inspected on receipt at the MFFF and rejects returned to HAC by 2018; rejects exceeding 10 items per year could potentially impact HAC processing schedule.

d. Processing of KAC material will likely not begin until 2018 to 2019.

e. All MFFF destined material will leave KAC by 2019.

Sch-5. KAC

a. KAC will receive MFFF rejects from 2016 until 2019.

b. Material received from KAC that is rejected by MFFF will be returned to KAC rather than sent directly to H-Canyon for processing. Rejects are not expected to exceed 10 items/year and must be returned before December 2018 to allow for flowsheet development and processing in H-Canyon (NNSA/OFMD, 2008). This requirement may change based on further consideration of section 5.5 ("Unacceptable AFS Item Return Requirements") of the MFFF/KAC interface control document (ICD) (NNSA/OFMD, 2008).

c. NNSA will establish alternate means for disposing of material rejected beyond December 2018 (NNSA/OFMD, 2008).

d. All material will be out of the KAC by 2019 to support KAC shutdown.

Evaluation of Programmatic Assumptions

Agreements between sites, facilities, contractors, & other entities: Successful execution of the proposed PuPP activities requires an unusually large number of interfaces with other activities at Savannah River. An essential element to the success of the planned PuPP activities is the identification and management of these organizational, facility construction, and operational interfaces.

To support processing operations, the KAC must provide the capability for un-packaging plutonium materials, repackaging, storing plutonium containers, dismantling FFTF fuel, oxidizing plutonium metal, and performing non-destructive examination. Before transferring material to the MFFF and H-Canyon, the KAC must transfer plutonium oxide samples to the F/H Analytical Laboratory and FFTF fuel specimens to SRNL for analysis. The F/H Laboratory will analyze 167 samples a year for 6 years (2014 – 2019) to support MFFF operations. These samples will be 5 – 10 grams each and will be analyzed for dissolution, plutonium isotopics and concentration, radiochemical impurities, and moisture. The SNRL will analyze 10 to 30 samples of FFTF fuel material (0.7 MT total) to enable flow sheet analysis and support processing in H-Canyon (NNSA/OFMD, 2008). The PuPP must also interface with the KAC Shuffler in the 910B area where testing for transuranic waste (TRU) and Mixed TRU will be performed. The H-Area is undergoing processing, control system, and life extension upgrades. The SRNL must undergo renovation to support plutonium disposition activities, and the F/H Analytical Laboratory will need to expand its scope to support KAC and MFFF operations (Gunter, Ewart, Bell, 2008). The MFFF, which must be prepared to receive material from KAC in the 2015 – 2016 timeframe, is under construction. The construction, upgrades, startup and operations associated with these facilities must occur in a smooth, coordinated manner if plutonium disposition operations are to be successfully implemented and mission objectives met.

In order for these activities to be successful, facility construction, upgrades, and operations must be fully funded and work must proceed on schedule. Clear lines of authority and interface controls will be essential. In the event that funding shortfalls and/or schedule delays occur, they must be closely coordinated and priorities established so that "work arounds" can be identified and implemented to minimize impacts and hopefully prevent schedule losses.

During the review, the team was presented with the status of ICDs in place or planned for plutonium disposition operations at SRS. A facility ICD to control interfaces internal to PuPP has been prepared and is approved by interface owners. Interfaces between the PuPP, safeguards and security functions, and other SRS facilities outside the project will be addressed at the end of the PuPP conceptual design. This effort will address functional interfaces, physical interfaces, and operational interfaces, and is expected to consist of a single document that lists all interfaces with "sub" ICDs for each interface control area (Carter, 2008).

Interfaces between other SRS entities beyond the PuPP facility, are largely in place. These include interfaces with other DOE sites and with shippers who conduct material transfers, interfaces for material preparation prior to receipt by PuPP, sample returns to H-Area operations from the SRNL and F/H Laboratory, H-Area transfer of liquid waste to the DWPF, MFFF operational interfaces with KAC, and DWPF interfaces for transport cask shipment to the federal geologic repository (Carter, 2008). The ICD for the MFFF/KAC interface (NNSA/OFMD, 2008) was provided to the team for review. This document is comprehensive and appears to adequately address functional elements of MFFF/KAC interfaces.

The team was also presented with schedule information during the review. This information focused primarily on the period 2008 through early 2010 when conceptual design for the PuPP will be completed.

Overall assessment: Work performed to date has been well planned and successfully implemented. Process steps, facility and equipment needs, construction requirements, upgrades, and staffing requirements appear to be well thought out and understood. Interfaces between the various SRS functions and facilities that will be needed for the overall plutonium disposition mission are partially developed. Interface controls need to be formalized in ICDs, and funding and schedule requirements should be identified in a fully integrated, resource loaded schedule with logic ties that include all of the elements required for plutonium disposition at SRS.

The review team believes that the identification of interfaces and preparation of control documents between the PuPP and other SRS facilities should begin as soon as possible to minimize uncertainties, assure that responsibilities of interfacing entities are clearly defined and understood, and to assure that appropriate measures are underway to accommodate those responsibilities in facility designs and operations. The review team also believes that SRS should consider individual documents for each interface rather than a single document with multiple interfaces, in order to make document maintenance and control more manageable.

In addition to early definition of interfaces, the review team believes that preparation of a fully integrated, resource loaded schedule with logic ties between program elements should be developed as soon as possible; first at a high level, and then at a more detailed level as design, planning, and program definition progresses. This will provide early identification of issues, establish a mechanism for tracking critical path activities, and begin to minimize and control project risks at an early stage.

Planning to support project & operational schedules: Plutonium disposition program risk at SRS will be minimized by using existing facilities such as H-Canyon or facilities currently under construction (e.g., MFFF). Nonetheless, the PuPP is influenced by several constraints. H-Canyon is planned to complete operations by the end of 2019 and begin deactivation in 2020. KAC is planned to begin supplying the MFFF with plutonium oxide in 2015. KAC, SRNL and F/H Analytical Lab upgrades must be completed in time to support KAC operations. Also the plutonium furnace oxidation tests must be successfully completed on schedule and the addition of gadolinium to H-Area waste as a neutron poison, if necessary, must be accepted.

The PuPP scope consists of KAC modifications needed for new plutonium preparation and packaging capabilities, increases in throughput capability of existing facility features, and infrastructure upgrades required to support project schedule. The project scope also includes improvements in the SRNL and F/H Analytical Laboratory consisting of additional equipment and laboratory module upgrades to perform material characterization analysis for MFFF, to provide support of H-Area facility processing, and to provide experimental support for H-Area flow sheet development (SRS M&O, 2007).

Planned operational improvements that are not part of the PuPP consist of a new dissolver that will be used for routine H-Canyon plutonium processing and for FFTF material processing, and a Bi-Cell vessel to provide plutonium solution storage surge capacity that will minimize processing delays with liquid transfers to the Tank Farm. No physical modifications are required for the Tank Farm, DWPF, or Solid Waste Management Facility (SRS M&O, 2007).

Overall assessment: Plans for the work that needs to be accomplished in the KAC, H-Area, the F/H Analytical Lab and SRNL appear to be appropriate, reasonable, and well thought out. Proposed schedules for some areas are tight but achievable if no major problems are encountered. An example is the furnace testing planned at SRNL to demonstrate oxidation of plutonium metals. Because schedules are tight; the review team believes it would be prudent to prepare contingency plans and identify contingencies for test failures and appropriate resource plans.

CSCC Project Footprint: The CSCC project was intended to perform destructive and non-destructive surveillance of 3013 containers, to stabilize plutonium, re-package plutonium, and provide long-term storage in accordance with the DOE 3013 standard. The mission need for the project was approved in June 2005. The project was discontinued in June 2008 and the scope absorbed into the PuPP (Gunter, Ewart, Bell 2008). The space identified in KAC for the CSCC was considered adequate for PuPP construction and operations and is now being used for that purpose.

Overall assessment: The area planned for the CSCC has been incorporated into the PuPP footprint. Preliminary conceptual design layouts for PuPP indicate that all of the required PuPP functions for packaging, un-packaging, processing, and storage fit into the PuPP footprint; however, the available space is tight with regard to accommodating craft workers during construction and equipment installation. This may require special measures to be taken as discussed later. The availability and effective use of the footprint originally planned for the CSCC appears to have been an appropriate and reasonable assumption.

SRNL Applied Technology Work: The SRNL will undergo renovation to provide flow sheet development capability for processing plutonium materials in 3013 canisters (Carey, 2008). These renovations will also support DMO furnace testing for the PuPP. 3.7 MT of the 7.8 MT of plutonium planned for disposition in the MFFF is currently in metal form. This metal will be converted to an oxide at KAC prior to transfer to MFFF for aqueous processing. The oxide will be produced through a DMO process demonstrated for the NNSA's PDCF as part of ARIES located at LANL. A furnace will be procured as part of the PuPP for this purpose, however it will be a smaller furnace from that used at LANL because of the smaller batch sizes and lower throughput required for the PuPP. In addition, separate furnaces will be used in the PuPP for oxidation and sintering whereas the ARIES furnace combined these functions into a single piece of equipment. Accordingly, testing of the PuPP oxidation furnace will have to be performed prior to installation at KAC to demonstrate that oxide meeting MFFF acceptance specifications can be consistently produced. SRS is currently conducting an analysis to determine the type and location of tests to be performed. It is possible that both surrogate and plutonium materials will be used for testing. To the extent possible, testing will be conducted at the SRNL. However, the SRNL will be handling plutonium samples on regular basis to support KIS and H-Canyon operations. These functions plus the close proximity of SRNL to the SRS site boundary limit the amount of additional plutonium the laboratory can accommodate within its safety basis (Carter, 2008). The safety limitation on plutonium quantity may prevent some of the preferred PuPP furnace tests from being performed in the SRNL. This may require that some of the PuPP furnace tests be performed off site (e.g. LLNL).

Overall assessment: This activity has the potential to impact PuPP schedule from several aspects: the inability to complete long lead procurement of the furnace in time to support testing, potential delays in testing caused by the need to complete tests with plutonium at a site outside of the SRS, and unacceptable test results that could require furnace design changes and retesting. The review team has concerns regarding the ability to complete tests in time to support the PuPP schedule if plutonium testing at a facility outside of SRS is required. The team believes that furnace procurement activities, test planning, and a decision on test material and location should move forward as quickly as possible to assure that testing can be completed on schedule.

Design Completion Targets: The PuPP design has established design completion targets of up to 15% for Conceptual Design and up to 50% for Preliminary Design. While this approach will provide higher confidence in the CD-2 project baseline and support early achievement of CD-3A, these targets exceed normal DOE practice and will require greater front end funding and engineering resources.

Overall assessment: The team commends the project and strongly supports their goal of exceeding typical design completion requirements for conceptual and preliminary design. Greater design completion will reduce the potential risk of cost overruns and schedule delays, and provide greater assurance of successfully completing the plutonium disposition mission. The project should make every effort in their budget plans and requests to secure the funding necessary to achieve those higher design targets.

Q Cleared Workforce: The availability of adequate workforce to satisfy PuPP needs is identified as a moderate to high risk by the project (Carter, 2008). The risk is of greatest concern for KAC during the latter stages of PuPP construction and for providing necessary MC&A support during operations when Q cleared workers certified by the HRP will require unescorted access inside the KAC. This concern arises from competing work activities at SRS and other facilities in the region (such as the Southern Nuclear Operating Company's Vogel Electric Generating Plant) that is anticipated to occur in the same timeframe. The PuPP project has indicated that they believe a sufficient number of workers with the skills required for construction and operations will be available when needed. The SRS plans to work with local technical schools to recruit and train new staff to perform those functions needed at the PuPP and other site facilities. The SRS also has the option of hiring radiological control personnel (identified as a low risk [Carter, 2008]) from outside the region.

Overall assessment: The review team agrees with the site's concern regarding the availability of cleared workers when needed for plutonium operations and the need to acquire additional workers from offsite sources. Recognizing the level of SRS construction and upgrade activity that is underway and that will continue to be underway during PuPP construction, the team encourages the SRS to identify facility workforce needs early and to develop detailed site wide and regional staffing plans. Hiring, recruiting, training, and security clearance efforts should be given a high priority to assure that adequate staffing is available when needed. Similar efforts should be focused on other critical project personnel since turnover of other workforce elements has also been identified as a moderate risk by the PuPP (Carter, 2008).

KAC Work Load Leveling: Space availability in the KAC to accommodate the workforce needed to meet PuPP schedule, is tight. Several hundred workers needed for construction and equipment installation may have to be present in the KAC at the same time in order to achieve the projected PuPP startup date. The SRS will attempt to control and balance craft activities during construction in KAC to provide a safe and efficient working environment that meets site requirements.

Overall Assessment: The review team is concerned that restricted space in the KAC could impact PuPP schedule and on timely startup. Staging, sequence of equipment installation, additional shifts, and other potential measures that could ease the number of craft personnel required in KAC at the same time, should be evaluated prior to construction and implemented as necessary to avoid project delays.

Safeguards & Security Personnel: The PuPP Risk Status Report presented to the review team and discussions between SRS and the review team, identified low and moderate risks associated with the availability of Safeguards and Security personnel to support PuPP and F/H Laboratory activities. These resources will be needed for PuPP construction, F/H Lab upgrades, and operations.

Overall assessment: The review team is concerned that a shortage of safeguards and security personnel could impact plutonium operations across the SRS site. The team recommends a greater level of coordination and evaluation of safeguards and security personnel needs to assure that shortages do not impact plutonium operations. As in the case with Q cleared personnel, staffing plans should be prepared and recruiting, hiring, training and clearance efforts undertaken as soon as possible to assure safeguards and security coverage is available when needed.

Permits and Licenses: Two bodies are responsible for the environmental requirements and permits that govern SRS facility operations; the South Carolina Department of Health and Environmental Control (SCDHEC) and the Environmental Protection Agency (EPA). Currently, KAC has SCDHEC Authorization Agreement Permits for Air Quality Control (TV-0080-0041), Storm-water Discharges from Large and Small Construction Activities (SCR100000), Storm-water Discharges Associated with Industrial Activities (SCR000000), and Discharges to Surface Waters (SC0000175) (Burbage, 2008). The SCDHEC Air Quality Control Permit (TV-0080-

0041) will be modified to register PuPP's related source changes and additions (e.g., diesel generators).

The U.S. Environmental Protection Agency (EPA) has issued regulations concerning clean air, water, and emissions at the SRS. No new National Pollutant Discharge Elimination System (NPDES – Clean Water Act) permits are anticipated for operations related to the PuPP, however modifications are expected. In the case of the Clean Air Act, new and modified permits are expected. National Emission Standards for Hazardous Air Pollutants (NESHAP) assessments will need to be performed to determine what new source permitting and monitoring may be required and if construction permitting and/or monitoring is required. A construction permit is anticipated for the PuPP sand filter.

With regard to the environmental impacts related to the proposed PuPP, a draft supplemental environmental impact statement (SEIS) pursuant to the National environmental Policy Act is being prepared for surplus plutonium disposition activities at the SRS. This document will evaluate the human and environmental impacts of processing certain plutonium in the KAC, H-Area, MOX and DWPF.

Overall assessment: The review team agrees with the PuPP team's assumption that compliance with the National Environmental Policy Act and environmental permitting requirements is expected that would significantly challenge the PuPP schedule.

Evaluation of Schedule Assumptions

As discussed above, in the section on programmatic basis and assumptions, the operation of the PuPP interfaces substantially and significantly with several other facilities and programs at SRS. Satisfactory completion of the PuPP will require that the schedule for design, construction, operation and ultimate decommissioning and decontamination be adequately integrated with the schedules for these other facilities and programs. In evaluating the schedule information provided, the review team kept in mind the following questions derived from the review lines of inquiry:

- What are the critical schedule and facility constraints that impact timely completion of the project?
- What are the bases for schedules for the project?

Because of the early phase of the proposed PuPP, this review focused on schedule assumptions associated with design and operation of the facility; this review determined that, in addition to the PuPP itself, schedule integration was needed with four other major facilities/programs at SRS: H-Canyon and associated facilities, LWO, MFFF and KAC (in which the PuPP Facility will be located). The schedule assumptions associated with PuPP and each of these interfacing facilities and programs are discussed below. Since the PuPP schedule assumptions appear to be largely derived from the schedule constraints imposed by these other facilities and programs, they are discussed last.

DOE-SR issued the Plutonium Disposition Project, Support Document for Mission Need and Justification (Mission Need Justification, M&O PUD-2007-00104), to provide the technical and programmatic information needed to support the CD-1 decision. The "Program Basis Statements" in the Mission Need Justification, Section 2.2, provide baseline assumptions of the program and Section 2.3 identifies program issues and risks. Further, NNSA has issued and maintains an ICD for AFS material transfers from K Area. That ICD lists five (5) assumptions and describes six (6) items that are "To Be Determined" (TBD)—whose resolution appears to be "assumed", at present.

H-Canyon: As discussed in the Plutonium Disposition Alternatives Analysis, H-Canyon and H-Area have an existing Enriched Uranium Disposition mission to disposition plutonium-bearing enriched uranium scrap material. This involves, at a minimum, processing about 0.7 MT of plutonium with significant enriched uranium through FY2011. Planned upgrades for the PuPP mission include a new annular dissolver, a new bi-cell tank, and the startup of the South Dissolving line in the HB Line. The H-Canyon is also scheduled to operate supporting HEU blend-down through FY2019 in support of the Enriched Uranium Disposition mission. To support PuPP approximately 3 MT of feeds not meeting MFFF specifications are planned to be processed through HB Line and H Canyon, along with up to 2 MT of other plutonium material, and dispositioned through several tanks in the High-Level Liquid Waste Operations program (discussed further below). The major schedule assumptions applicable to H Canyon, but which also support PuPP are:

a. Operations of H-Canyon will continue through 2019, but not extend beyond that date.
b. Approximately 1.2 to 1.9 MT of plutonium (up to 2 MT discussed above) will be processed through H Canyon prior to 2014; the remaining material to be processed at H-Canyon will be completed by 2019.

The first assumption is consistent with present planning concerning the H Area and, further, as discussed in the programmatic section above, is consistent with present schedule regarding the operations of H Canyon. The fact that H-Canyon is planned to begin to undergo deactivation in approximately October 2019 is reflected in several Nuclear Materials planning documents; for example, Nuclear Materials Functional Areas, PBS SR-0011B, 0011C & 0012, Risk Management Plan, Y-RAR-G-00023, "Nuclear Materials Risk Management Plan". The Nuclear Materials Risk Management Plan states:

> "H-Area nuclear materials processing facilities will operate through September 30, 2019, to disposition Department of Energy (DOE) enriched uranium materials, spent nuclear fuel and up to 2 MT of low grade plutonium oxide."[9]

Several system modifications will be required to the H Canyon to achieve this processing, as mentioned above; in addition, the South Dissolving line in HB Line, which has not operated since the late 1980's will have to be refurbished, undergo required operational testing and nuclear facility readiness reviews. These activities are recognized in the existing H-Area planning and scheduling; however detailed processing schedules for H-Canyon and HB line were not available to the review team to verify that the required plutonium processing can be

[9] The 2 MT of plutonium indicated in this quote preceded the revision of the preferred option, eliminating small-scale vitrification.

completed by 2019. Further, this assumption a, above, is addressed by Program Basis Statements 2.2.3 and 2.2.5, in the PuPP Mission Need and Justification.

The second assumption, processing of up to approximately 2 MT of "other" plutonium materials, is being pursued to disposition this material prior to the need for extensive security upgrades in H-Area. DOE-SR is presently developing an implementation plan for revised security guidance issued by DOE Headquarters that includes a strategy for processing this material under the existing H-Area security waiver. This strategy—which is described as "aggressive" in the Plutonium Disposition Alternatives Analysis—includes several assumptions that have the potential to impact the PuPP; therefore, the progress of this implementation plan will need to be followed closely by the PuPP team. This assumption b, above, is addressed by Program Basis Statement 2.2.10 in the Mission Need and Justification.

Mixed Oxide Fuel Fabrication Facility (MFFF): The MFFF and the associated PDCF are managed by the NNSA Office of Fissile Materials Disposition. The major function of the MFFF and PDCF is to take surplus weapons-usable plutonium, remove impurities, and mix it with uranium oxide to form MOX fuel pellets for commercial reactor fuel assemblies. DOE-EM has worked with the NNSA to develop agreements to process additional plutonium oxide material, known as alternate feedstock (AFS); AFS is proposed to be prepared in the PuPP, received by the MFFF, purified in the aqueous polishing line and used in the MFFF. The PuPP schedule assumptions related to MFFF are:

a. MFFF will begin receipt of KAC material as early as 2015;
b. MFFF will begin operations in September 2016; it will initiate operations using AFS and polished/unpolished plutonium oxide from the ATLAS and ARIES processes at LANL;
c. Material from K Area will be receipt inspected at the MFFF and rejects returned to HAC by 2018; rejects exceeding 10 items per year could potentially impact HAC processing schedule;
d. MFFF processing of KAC material will likely not begin until 2018 to 2019; and,
e. All MFFF destined material will leave KAC by 2019.

Assumptions 4.2 and 4.3 in the initial version of the ICD state that MFFF will initiate operations with materials including the AFS material from the proposed PuPP; further these assumptions state that MFFF "completion of cold startup" and commencement of "hot startup operations" is in 2016. This appears to be broadly consistent with receipt of KAC material and initiation of operations in 2016 (assumption b, above). The Mission Need and Justification addresses these assumptions, in Program Basis Statement 2.3.11 and 2.3.14

Assumption 4.5 of the ICD notes that, "for planning purposes," material "rejected by MFFF and returned to KAC should not exceed 10 items per year and that all returns must be received at KAC before December 2018." That assumption goes on to note that "NNSA will establish alternate means to dispose of material rejected beyond December 2018." Coordination and verification with NNSA should be pursued with respect to this assumption. This assumption does not appear to be addressed in the PuPP Mission Need and Justification.

Assumption 4.2 of the ICD notes that "MFFF will initiate operations using AFS material from ARIES at LANL." The Mission Need and Justification expands on this assumption, in Program Basis Statement 2.2.14, where it makes an identical statement to assumption d, above.

Assumption e, above, is not included in the ICD, but is included in the Mission Need Justification, as Program Basis Statement 2.2.11, "KAC will be deinventoried of MFFF destined material by 2019."

In summary, some of the above assumptions are addressed by either the ICD or the Mission Need and Justification, and several are addressed by both documents. However, these assumptions would benefit from further coordination with NNSA, and may be refined as NNSA and PuPP proposed activities progress.

K-Area: KAC is one of five (5) SRS reactor areas used originally to produce special nuclear materials. It is being used temporarily to provide safe, secure storage of plutonium, highly enriched uranium and a large volume of heavy water. Because of security upgrades completed to accomplish this existing mission, KAC was selected as a logical site for construction of the PuPP capability. PuPP schedule assumptions that are dependent on the KAC schedule are:

a. KAC will receive MFFF rejects from 2016 – 2019;
b. Rejects from MFFF after completion of H-Canyon dissolving campaigns will be dispositioned by NNSA; and,
c. All MFFF material will be removed from KAC area by 2019.

Assumption a is covered by the ICD in its "Assumptions" 4.4 and 4.5, which set a cut-off date for shipping rejects to KAC of December 2018. To address management of material rejected by MFFF (assumption b, above), the ICD states that "NNSA will establish alternate means to dispose of material rejects beyond December 2018." However, coordination and verification with NNSA should be pursued concerning this matter. The Mission Need and Justification addresses these assumptions in Program Basis Statements 2.2.11, 2.2.12 and 2.2.14; although, in 2.2.12, it simply notes: "Rejects after HAC dissolving campaigns are completed will dispositioned by others. These materials will not be sent to KAC." Accordingly, the assumed removal of MFFF material from KAC by 2019 (assumption c, above) appears to need further coordination with NNSA.

High-Level Liquid Waste Operations: LWO encompass an integrated series of facilities at SRS that safely manage the existing waste inventory and disposition waste stored in the tanks to a final glass or grout form. The series of facilities include facilities for waste: storage, evaporation, removal, pre-treatment, vitrification, grouting, and disposal. They are discussed in the Life-cycle Liquid Waste Disposition System Plan (LWO-PIT-2007-00062, Revision 14, "LWO Systems Plan"). The assumption below applies to LWO:

a. LWO will have transfer lines available through 2023 to accommodate sludge batches produced from H-Canyon processing of PuPP materials that will occur through 2019.

The Mission Need and Justification addresses this assumption in Program Basis Statements 2.2.6, which states "LWO has available transfer lines through 2023 to accommodate neutralized plutonium solutions to support H-Canyon closure date and Sludge Batch preparations." Several places in the LWO Systems Plan discuss support for nuclear materials stabilization, notably Section 5.6.1, "Supporting Nuclear Material Stabilization"; however, the PuPP is not explicitly addressed and other places in the Plan still reference the plutonium vitrification option (for example Section 3.4, Bullet 4).

PuPP Facility: The PuPP and associated facilities are summarized elsewhere in this report. The schedule assumptions specific to the proposed PuPP Facility are as follows:

a. The PuPP Facility will begin operations in 2014;

b. The PuPP Facility will have a 5.25 year operational life;

c. Engineered equipment items, including process gloveboxes, certain laboratory equipment, HEPA filters, and analytical equipment, will require long-lead procurement to meet KAC/PuPP startup schedule (tight schedule makes this a project risk); and,

d. Process glove boxes are considered engineered equipment and are currently planned to be fabricated on-site. On site fabrication experience with gloveboxes is well documented and cost/schedule implications are known.

Initiating PuPP Facility operations in 2014 is included in Section 5 of the Mission Need and Justification (assumption a, above), under "Specific Bases," it notes (second bullet) that "The project will be designed, procured, constructed and started up in June 2014." Therefore, this would appear to be a "present schedule" value, rather than a major project assumption; the same would appear to be true for the planned 5.25 year operational life (assumption b, above), which can be found in Section 5.3.1, "Project Assumptions" under the overall section 5.3, "Budgetary Technical Scope". While it could be argued that this is simply a calculation based on the projected startup date and the date that shipments out of KAC must be completed, if it materially impacts equipment design and process flow development, it should be more prominent.

Procurement assumptions for engineered equipment (assumptions c and d, above) were identified in the Acquisition Strategy for the Plutonium Disposition Project, Revision 3, October 23, 2006). It is not clear that they have been carried forward to more recent planning documentation. As they appear critical to meeting the tight project schedule, it is advisable to make them more prominent in revised project planning documentation.

Overall Assessment: At present, the only detailed schedule available for the PuPP Facility addresses only the conceptual design effort. As noted in the above discussion, many of the schedule assumptions needed to manage the project have been identified in various program documents; however, some assumptions warrant additional attention, for example: the impact, if any of the stated operational life of the PuPP Facility, and the need to start the scheduling effort for procurement of "engineered equipment" as soon as practicable. It appears that other scheduling observations noted above can be adequately addressed by the early development of an integrated project schedule. In addition, assumed receipt of feed material at the MFFF as early as 2015 will need to be validated against NNSA plans for the MOX facility and constraints contained in the licensing documents for MFFF, and the assumption of NNSA's acceptance of material returned from MFFF after 2018 need to be reconfirmed and coordinated with NNSA as project planning progresses.

7. Evaluation of the Cost Estimates

In this section, we provide our assessments of two components of the cost estimate for the PuPP: the capital costs of the project and the annual operating costs of the project. However, first, we identify the underlying assumptions of the cost estimates.

Assumptions Key to Our Evaluation of the Cost Estimate

To carry out the evaluation, the ITR team reviewed the underlying assumptions to the capital cost estimate as presented in the identified Mission Need and Justification Report, Rev. 1. The assumptions that were deemed key to our evaluation are:

- The Program will be funded to support project and operational schedules. This includes the planned HAC infrastructure upgrades and maintaining all of the cited facilities to sustain continued operation.
- Escalation has been calculated at rates provided by DOE's Office of Engineering and Construction Management (2.6 percent compounded per year) and applied to the estimated centroid of "total estimated cost" expenditures (October 2011) and the centroid of the "other project cost" expenditures (October 2012).
- No "person-in-charge" (PIC) will be required for construction activities. If a PIC is required, the PIC will be provided by Operations and not funded by Construction.
- The process gloveboxes are currently planned as engineered equipment procurements.
- It is expected that adequate manpower will be available to support this project. This is a significant risk based on other major upcoming construction activities in the region.
- Unescorted access to the KAC will require "Q" cleared workers that have been certified through the HRP for the latter stages of the KAC project scope. It is anticipated that workers for the first half of the construction duration will not require HRP clearance. Uncleared workers may be used for work outside the K Protected Area.
- Applied Technology Development (ATD) work will be performed by SRNL. The schedule detail shown for the ATD includes the portion required for preliminary design and the ongoing work in support of the federal repository.

With one minor exception, these key assumptions as reasonable. The exception is the assumption for escalation. We address our concerns about that assumption, when we discuss the basis for the escalation estimate in the following section.

The Capital Cost Estimate

The total capital cost is estimated at $500 million (Plutonium Disposition Program Overview briefing, August 11, 2008). This value comprises three elements: the cost of planning, engineering and design, $74.5 million; the total project estimated cost, $315 million; and other project costs, $110.5 million. The estimates are based on FY 2008 costing rates, and the accuracy level is SRS Estimate Class 5.[10]

The primary source documents for this evaluation of the capital cost estimates were (1) the handout slides, "Project Cost/Schedule/LCC Estimates and Basis Breakout," that SRS presented on August 13, 2008; and (2) the WSR cost estimate basis document, "Alternative Plutonium Disposition Project and Alternative Option Estimates," IOM Number: SBM-EST-07-0031, November 28, 2007.

The review team evaluated 10 elements of the overall basis for the cost estimate. The first element is the basis for the design cost estimate. This estimate was based on a parametric factor, which we agree is appropriate for the current level of maturity of the project's design. This factor (30 percent of the construction field cost) is consistent with other design parametric cost factors that we've seen used in the DOE complex for similar type work. Thus, we assess this element of the overall cost basis as reasonable.

The second element is the use of a work breakdown schedule (or similar type approach) for identifying construction activities, or groupings of activities, for which cost and schedule duration estimates were made. We found that the estimate was based on a relatively detailed and comprehensive work breakdown structure. The breakout is more than minimally adequate for the desired level of accuracy of the estimate. Thus, it was clear to us there was a good deal of thought and preparation put into the development of this cost estimate.

The third element is the basis for the program management and construction management estimate. This estimate was based on parametric factors, which we found appropriate for the current level of maturity of the project's design. Those factors (1.5 percent of total engineering and construction field cost for project management, and 32 percent of construction field man-hours for construction management) are consistent with other design parametric cost factors that we've seen used in the DOE complex for similar type work. Thus, we assess this element of the overall cost basis as reasonable.

The fourth element is the basis for the building commissioning and start-up costs. This estimate was based on parametric factors, which we found appropriate for the current level of maturity of the project's design. Those factors (2.4 percent of construction man-hours for start-up costs in the total estimated cost category, and 3.2 percent of the total estimated cost for the other project costs category) are consistent with other design parametric cost factors we've seen used in the DOE complex for similar type work. Thus, we assess this element of the overall cost basis as reasonable.

The fifth element is the basis for the estimate's allowance for contingency. The estimate identified three parts for overall contingency to the total project cost: estimate contingency; technical and programmatic risk; and schedule uncertainty. The estimate contingency comprised allowances for both the contractor and DOE. For the contractor, the contingency allowance is 25

[10] Essentially, this means that the accuracy level of any particular estimate is such that the estimator is 80 percent confident that the actual value of the estimated cost may be as much as 50 percent greater than the identified cost estimate or as much as 20 percent lower than the identified cost estimate.

percent of the total project estimated cost and the other project costs. This is a common factor applied in government and industry to order of magnitude cost estimates at this stage of design maturity to hedge against a cost overrun with 80 percent confidence. For DOE, the contingency allowance is 8 percent of the total project estimated cost and the other project costs. This factor is consistent with other contingency factors that have been applied in the DOE Complex to projects to hedge against cost overruns that DOE might be responsible to cover. Thus, we find the estimate's contingency factors are reasonable.

The technical and programmatic risk allowance is 12 percent of the total project estimated cost and the other project costs. This factor is consistent with other technical and programmatic risk factors we've seen applied in other DOE construction projects of similar complexity. Thus, we find this risk factor is reasonable.

The schedule risk factor is 3 percent of the total estimated cost and the other project costs. This factor is a hedge against a cost overrun due to schedule delays with 80 percent confidence. This is not a common, rule-of-thumb factor. Instead, it is an estimated factor that SRS developed after considering the security-induced scheduling challenges of this project. The total magnitude of this contingency is about $8 million. We find it a reasonable estimate.

The sixth element is the basis for the inflation factors used in the estimate. The estimate is premised on a 2.6 percent annual inflation rate applied to the centroid of the total estimated cost estimate. The 2.6 percent annual rate is a legacy of DOE guidance issued in the earlier part of this decade. At the time, the rate was a useful inflation factor. However, given recent economic conditions and forecasts for construction-related commodities (such as steel and cement), we think this factor will underestimate construction cost escalation over the next 5 years. We think an annual rate of 4.15 percent is a more useful escalation factor.[11]

While we acknowledge that the centroid approach is commonly used in cost estimating at early stages of conceptual design, we think it substantially underestimates the impact of cost escalation. To illustrate this point, we identify a cash flow that roughly approximates the total project estimated cost in constant 2008 dollars, as reflected in the SRS estimate (Table 1). The total project estimated cost (of $168 million in constant 2008 dollars) comprises the direct field cost of construction plus the "business unit" costs of engineering, designing, and managing the construction. Essentially, these are the direct costs upon which the other project costs (i.e., the "indirect costs") are calculated through various parametric factors. Thus, it is critical to estimate the escalated value of those direct costs as reasonably well as possible.

Table 1. Illustrative Set of Cash Flow Intended to Approximate the Plutonium Disposition Project's Direct Costs of Construction (The Total Project Estimated Costs in $ Millions)

Fiscal year	2008	2009	2010	2011	2012	2013	2014	Total
Construction ($2008)			$10.0	$50.0	$60.0	$35.0	$13.0	$168

[11] This is the average rate projected for construction cost escalation in a July 2007 draft report prepared the CF-70, in the Office of the Chief Financial Officer, LMI, "Construction-Related Cost Escalation Rates," Draft, June 2008.

The SRS assumption is that the centroid is at the end of FY 2011. Thus, the compounded inflation rate from 2008 to 2011, assuming an annual escalation rate of 2.6 percent, is 8 percent.[12] We then multiply this 8 percent rate by the total project estimated cost of $168 million to determine the escalation cost impact of $13.4 million. This is the escalation amount identified in the SRS cost estimate (WSR, 2007).

In contrast, if we estimate the impact of escalation on a year-by-year basis, using the same 2.6 percent rate, we arrive at a value about one-third greater due to effects of inflation: $18 million. This is reflected in Table 2. In this set of cash flows, the "Construction ($2008)" row approximates the same rough estimate of annual construction-related expenditures that SRS needed to make in order for it to estimate the centroid — the center of mass of the expected cash flows over the construction period. These cash flows are represented in constant 2008 dollars (i.e., in the hypothetical purchasing power of a dollar in 2008). These values do not reflect the likely actual costs in those years. Thus, it is a common technique to adjust the constant dollar estimates to more accurately reflect the likely effects of inflation in those subsequent years. This is done in the next row, "Construction ($ escalated)." For example, let's assume that SRS estimates the construction-related costs in 2010 at $10 million in constant 2008 dollars. Then, assuming that construction costs escalate annually at a rate of 2.6 percent, SRS would adjust that value to $10.5 million to reflect likely actual costs.[13] The bottom row, "Escalation," reflects the impact of escalation in each year with respect to the constant dollar estimate. Thus, following our example, costs for activities scheduled in 2010 have escalated by $500,000 over their estimated costs in 2008.

Table 2. Illustrative Cash Flow with Annual Impacts of Construction Cost Escalation Assuming an Annual Rate of 2.6 Percent (Dollars in Millions)

Fiscal year	2008	2009	2010	2011	2012	2013	2014	Total
Construction ($2008)			$10.0	$50.0	$60.0	$35.0	$13.0	$168
Construction ($ escalated)			$10.5	$54.0	$66.5	$39.8	$15.2	$186
Escalation			$0.5	$4.0	$6.5	$4.8	$18	$18

If we consider the higher forecast of annual construction cost escalation of 4.1 percent, the effects of inflation are even more dramatic. The total impact is $29 million — more than double SRS's estimated $13.4 million value.

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12 The compounded rate can be found by using this formula: $(1+f) = (1+r)^{(k-b)}$ where f = the compounded rate, the variable of interest; r = the escalation rate, 2.6%; k = the year of interest for the inflation, 2011; and b = the base year, 2008. Thus $f = (1.027)^3 - 1 = 0.08$

13 To arrive at the actual costs, one could use the formula, $A\$ = R\$(1+f)^{(k-b)}$, where A$ = actual dollars, the variable of interest; R$ = real (constant) dollars, $10; f = the inflation rate, 0.026; k = the year of interest, 2010; an d b = the base year, 2008. Thus $A\$ = \$10(1.026)^2 = \$10.5$.

Table 3. Illustrative Cash Flow with Annual Impacts of Construction Cost Escalation Assuming an Annual Rate of 4.15 Percent (Dollars in Millions)

Fiscal year	2008	2009	2010	2011	2012	2013	2014	Total
Construction ($2008)			$10.0	$50.0	$60.0	$35.0	$13.0	$168
Construction ($ escalated)			$10.8	$56.5	$70.6	$42.9	$16.6	$197
Escalation			$0.8	$6.5	$10.6	$7.9	$3.6	$29

The seventh element is basis for the adjustment factors for labor productivity. SRS identified adjustment factors for a wide range of location and work area conditions, including radiological control, heat stress, and hazardous material — just to name a few. The variety of conditions and the range of values among the various factors suggest that SRS gave considerable thought to the potential effects of congestion to a construction schedule in a 6,000 square foot confined area of a highly secured, nuclear facility. Consequently, we assess their adjustment factors as reasonable.

The eighth element is confidence level of the overall estimate. The SRS estimate hedges against the risk of a cost overrun with an 80 percent level of confidence. We think that is a prudent level.

The ninth element is the acquisition strategy for obtaining the construction, such as the type of contract that will used for construction (e.g., "cost plus award fee" or "fixed priced"). We learned that SRS has not developed this strategy yet, but will develop it in time for the CD-1B decision. We are satisfied with that approach.

The tenth element is the project delivery method for the construction. SRS is planning to use a standard "engineer, procure, construct" approach (sometimes referred to as "design, bid, build"). Given the complexity and risk associated with this project, we find this approach as exceptionally prudent.

The other cost categories ("other project costs" and "planning, engineering, and design") are indirect costs factored to the direct costs of the total project estimated costs. The factors used by SRS to determine those indirect costs are consistent with factors used in similar construction projects throughout the DOE complex. We assess them as reasonable.

The Annual Operating Cost Estimate

SRS identified annual operating costs associated with Plutonium Preparation Project through FY 2030. These operating costs included decontamination and demolition (D&D) costs for the KAC facility and 2 years of operating costs for the MFFF (in FY 2027 and 2028) and 1 year of operating cost for the DWPF (in FY 2029) — should those facilities must remain open beyond their budgeted service life to complete the processing and disposal of the plutonium.

Our primary source documents for the annual operating cost estimates were (1) the Plutonium Disposition Project Support Documentation for the Mission Need and Justification Report, Revision 1, M&O PUD-2007-00104, page 33; Appendix A – Alternative Analysis, Plutonium Disposition Alternative Analysis, Revision 1; Y-AES-G-00001, March 2008, pages 268 through 270; and (3) supporting worksheet, "Alternative Analysis Cost Profile," printed on August 12, 2008.

We identified the following two assumptions (found in the Mission Need and Justification Report, Rev. 1) as key to the operating cost estimates:

- The KAC facility lifecycle cost includes the facility headcount with Work Authorization Documents for support staff (e.g., analytical laboratories, fire protection, field services WSMS, PDCS, SRNL, Health Physics, etc.). The consumables (utilities, laundry, and supplies) are also reflected in the lifecycle cost.
- The SRNL and the F/H Analytical Laboratory lifecycle cost for FY 2015 through FY 2021 includes the labor, materials, and equipment and subcontract services needed to support the Plutonium Disposition mission.

We have no objections to those assumptions.

For our evaluation of the annual operating costs, we considered the basis for two primary cost categories: the KAC operating costs over the 6 years of expected operation, FY14 through FY19; and the D&D costs for the KAC facility.

For the KAC operating costs, SRS based its estimate on the HB-Line facility operating costs. We find that reasonable, given that HB-Line and KAC are similar plutonium processing facilities.

For the D&D of the KAC costs, SRS based its estimate on the estimated deactivation cost of HB-Line along with the actual removal cost associated with 247-F contaminated processes. We assess that as a reasonable basis for the estimate.

Overall Assessment

For the project's stage of development, the estimates for the capital costs and annual operating costs for the Plutonium Preparation Project were competently prepared and the values are reasonable. However, for the CD-1B estimate, we suggest that SRS consider a higher rate of expected annual construction-related inflation (say, 4.1 percent), and use a more sophisticated technique to estimate of the effects of inflation.

8. Findings and Recommendations

The objective of this review is to verify that the assumptions upon which the PuPP approval decision (revised critical decision (CD) 1A, June 27, 2008) was based are appropriate and reasonable, including that:

- the planning to process the amount and types of material is technically sound;
- all relevant programmatic considerations for proceeding with this processing approach have been identified and are being appropriately addressed; and,
- the cost estimates for the planned project are inclusive and reasonable.

A detailed review of PuPP primary assumptions is provided in this report. The findings and recommendations of this review are:

1. For disposition of up to 5 MT of the plutonium, the assumption that the license application for the planned federal geologic repository at Yucca Mountain can be amended to allow an increased plutonium concentration in the vitrified waste form produced by DWPF is not a valid assumption or acceptable under DOE's approach for the repository. Consequently, alternative disposition paths and/or processing plans for this material need to be developed. In this regard, the associated assumption concerning increased criticality limits for DWPF waste processing tanks may not be necessary.
2. The PuPP has developed an approach to the disposition of the remainder of the 12.8 metric tons of plutonium material that has a sound technical basis, with a limited set of technology challenges to overcome.
3. The proposed PuPP requires an unusually large number of programmatic interfaces and is highly schedule constrained. For example, the PuPP is constrained by the scheduled completion of H-Canyon operations by 2019. Possible delays in overcoming technology development and demonstration requirements, necessary administrative and regulatory requirements, and/or meeting procurement and construction schedules reduce the probability of the project achieving the project goals in the allowed time. The PuPP recognizes these risks; however, the PuPP should rapidly develop detailed plans to mitigate or overcome each of the major risks to project success.
4. The proposed PuPP has established a planning process that is commensurate with the current stage of the project. Project planning includes appropriate consideration of technical and safety requirements, interfaces internal and external to the PuPP, project constraints, project scheduling and cost estimating. Tracking should be maintained throughout the program, along with on-going verification of the validity of key assumptions, using the project risk management system.
5. A high level schedule with necessary logic ties currently is available only for the conceptual design stage of the project. A high level schedule for the entire project should be developed as soon as possible that includes all necessary logic ties: 1) within the PuPP and 2) to critical facility improvements and processes external to the PuPP on which the PuPP is dependent (e.g., H-Canyon upgrades). This will provide early identification and

a mechanism for tracking of critical path items and dependencies within and external to the project.

6. Execution of the proposed PuPP requires an unusually large number of interfaces with other projects, facilities and organizations to successfully achieve the mission objectives and schedule. Thus, a high level of coordination is required. The review team is concerned that up to the time of the on-site review only one DOE federal employee was allocated to the project on a full-time basis. A plan is under development for increased federal personnel support to this proposed project, which should be finalized and implemented expeditiously.

7. Most of the technical operations needed for completion of the PuPP are based on demonstrated technologies, with recent experience either at Savannah River Site (SRS) or within the DOE complex. The notable exceptions are:

   Within the Proposed PuPP

   a. The design and operation of the furnace for plutonium metal oxidation, which will require development and demonstration as part of the project's technology maturation plan. The review team is concerned that this is a relatively long-lead time requirement that needs increased early attention to assure timely availability of this critical process step. Currently, Savannah River National Laboratory (SRNL) does not have the facilities necessary to process the quantities of plutonium necessary to demonstrate furnace performance and therefore furnace development and demonstration may need to be carried out at an alternative DOE site. A technology maturation plan for the plutonium metal oxidation process is under development. The PuPP should take advantage of the technology development and lessons learned for the Advanced Recovery and Integrated Extraction System (ARIES) project at Los Alamos National Laboratory (LANL) to the greatest extent practical, and completing the technology maturation plan currently underway as soon as practical, to mitigate technical and schedule risks associated with this processing step.

   b. Disassembly of FTFF fuel and test pin assemblies with varying geometries and fuel pin compositions. Expertise is being sought from Hanford personnel involved in the production of FTFF fuel assemblies.

   External to the Proposed PuPP

   c. The availability of a certified interim plutonium storage container (other than 3013 canisters) and associated closing stations (i.e., crimping) to provide storage and transfer of materials processed at KAC.

   d. Verification and acceptance of gadolinium as a poison within the sludge batches (if necessary) should be pursued and must be consistent with the limits of the Yucca Mountain license application.

   Each of the above issues is discussed in more detail in this report with additional specific recommendations.

8. The proposed PuPP has several challenges that have the potential to adversely impact timely completion of the mission:

During Construction

a. The availability of a sufficient number and mix of cleared, skilled craft workers during KAC construction activities. The proposed PuPP will be in competition with other projects within and external to SRS, especially as other nuclear construction projects progress. The requirement for security cleared workers for the proposed PuPP will exacerbate this challenge. The proposed PuPP, in coordination with other SRS activities, should develop a plan for insuring the availability of sufficient numbers of security cleared, skilled craft workers.

b. The more than 150 skilled craft workers that are currently estimated to be needed to be working at the same time within the perimeter intrusion detection and assessment system (PIDAS) at KAC during the peak of construction activities. The very limited space where renovation is to occur and the logistics of security controlled ingress and egress from the construction locations will constrain construction efficiency. More detailed planning of construction activities should be carried out with emphasis on reducing the number of workers required to be working concurrently in the space at KAC designated for renovation to support the PuPP.

During Operations

c. The processing of the FFTF fuel is likely to be the rate limiting process within the PuPP Facility. The estimated time of 4.5 years for the completion of the processing of the fuel assemblies is less than the scheduled five years, but does not explicitly consider potential inefficiency in operations due to shift changes or unplanned events. Parallel processing of both the 3013 containers and FFTF fuel will be needed for the proposed PuPP to conclude its mission before the scheduled closure of the H-Canyon. As a result of these considerations, the time and motion study should be re-visited to confirm that the processes in the PuPP Facility will be completed in the assumed five-year period of operation.

d. The anticipated high tempo of plutonium material transfers under necessary security and safeguards during the operational phase of the proposed PuPP. This will be an important consideration in achieving desired overall processing throughput. Coordination with security planning, which should be included as part of time and motion studies, should be an integral and early part of continued project development.

e. Processing delays at facilities beyond proposed PuPP control, including H-Canyon and DWPF. In-process storage surge capacity should be carefully evaluated to mitigate this schedule risk to the extent practical.

9. The safety strategy for the proposed PuPP is consistent with DOE required practices and procedures. Early assumptions regarding strategies to mitigate the potential impacts of a fire scenario in the KAC during plutonium processing are appropriately conservative for the current stage of the project. However, opportunities may exist to reduce the project cost associated with safety systems through subsequent evaluation (e.g., requirement for a safety class active containment ventilation system using sand filtration). The following actions are recommended to clarify this need:

a. The safety-in-design risk and opportunities assessment report should include a value engineering study that considers alternatives to an active safety class ventilation system, such as controlling combustible loading or upgrading the fire suppression system.

b. DOE-SR should review the 3013 container integrity analysis carried out by LANL and then if needed, should recommend to the Material Identification and Surveillance Working Group (at LANL) the development and implementation of a program to fire test 3013 containers to provide a more accurate bounding fire safety analysis. Development of the test plan will require buy-in from all parties responsible for acceptance of the test results.

10. The project cost estimates have followed generally accepted procedures and are appropriately thorough for the current stage of the project. The following are recommendations for improved estimates:

a. Use more current forecasts of escalation rates and apply more sophisticated modeling techniques to estimate the effects of escalation.

b. The next update to the schedule and cost risk estimates should be based on application of probabilistic risk analysis techniques.

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