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LOCKHEED MARTIN

Characterization of Candidate DOE Sites for Fabricating MOX Fuel for Lead Assemblies

Fissile Materials Disposition Program

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CHARACTERIZATION OF CANDIDATE DOE SITES FOR FABRICATING MOX FUEL FOR LEAD ASSEMBLIES

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ACRONYMS

ALARA	as low as reasonably achievable
ANL-W	Argonne National Laboratory-West (at INEEL)
APSF	Actinide Packaging and Storage Facility (at SRS)
ARIES	Advanced Recovery and Integrated Extraction System (at LANL)
ASTM	American Society for Testing and Materials
BET	Brunauer, Emmett, Teller (surface area analysis)
BIO	basis of interim operations
BMS	balance magnetic switch
BWR	boiling-water reactor
CFR	*Code of Federal Regulations*
CMR	Chemistry and Metallurgy Research (at LANL)
CSRA	Central Savannah River Area
D&D	decontamination and decommissioning
DA	destructive assay
DNFSB	Defense Nuclear Facility Safety Board
DOE	U.S. Department of Energy
DP	Defense Programs (DOE)
DUO_2	depleted uranium oxide
EA	environmental assessment
EBR-II	Experimental Breeder Reactor-II (at ANL-W)
EIS	environmental impact statement
FAA	Fuel Assembly Area (at Hanford)
FASB	Fuel Assembly and Storage Building (at ANL-W)
FFTF	Fast Flux Test Facility (at Hanford)
FMEF	Fuels and Materials Examination Facility (at Hanford)
FMF	Fuel Manufacturing Facility (at INEEL)
FY	fiscal year
HB	H-Canyon B-Line (at SRS)
HEPA	high-efficiency particulate air
HETB	Hardened Engineering Test Building (at LLNL)
HM	heavy metal
HVAC	heating, ventilating, and air conditioning
IAEA	International Atomic Energy Agency
IDS	intrusion detection system
INEEL	Idaho National Engineering and Environmental Laboratory
LA	lead assembly
LANL	Los Alamos National Laboratory
LEU	low-enriched uranium
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LWR	light-water reactor
M&O	management and operating
MA	material accountability
MAA	material access area
MBA	material balance area
MC&A	material control and accountability
MD	Office of Fissile Materials Disposition (DOE)
MO-1	Mixed Oxide-1 (shipping packaging)
MOX	mixed oxide
MT	metric ton
MTHM	metric ton heavy metal

MW	mixed waste
NDA	nondestructive assay
NDE	nondestructive evaluation
NDT	nondestructive testing
NEPA	National Environmental Policy Act of 1969
NRC	U.S. Nuclear Regulatory Commission
O:M	oxygen-to-metal ratio
OPSEC	operational security
ORNL	Oak Ridge National Laboratory
ORR	operational readiness review
PA	protected area
PDAC	pit disassembly and conversion
PF-4	Plutonium Facility-4 (at LANL)
PF-I3	Plutonium Facility-Increment 3 (at LLNL)
PFP	Plutonium Finishing Plant (at Hanford)
PIDAS	Perimeter Intrusion Detection and Assessment System
PIE	postirradiation examination
PNNL	Pacific Northwest National Laboratory
POC	point of contact
PPA	property protection area
PPHF	plutonium-processing and -handling facilities
PPR	powder, pellets, and rods
PSAP	Personnel Security Assurance Program
PSAR	preliminary safety analysis report
PWR	pressurized-water reactor
PuO_2	plutonium oxide
QA	quality assurance
R&D	research and development
RADSAB	radiological sabotage
RAMROD	Radioactive Materials Research, Operations, and Demonstration Facility (at LANL)
ROD	record of decision
S&S	safeguards and security
SAR	safety analysis report
SET	Site Evaluation Team
SNM	special nuclear material
SRS	Savannah River Site
SSSP	site safeguards and security plan
SST	safe secure trailer
TA	Technical Area (at LANL)
TGA	thermal gravimetric analysis
TRU	transuranic
TSCM	technical surveillance and countermeasures
TSR	technical safety requirement
UN	uranium nitride
USF	Uranium Solidification Facility (at SRS)
VA	vulnerability assessment
WIPP	Waste Isolation Pilot Plant
ZPPR	Zero Power Physics Reactor (at ANL-W)

EXECUTIVE SUMMARY

The Office of Fissile Materials Disposition (MD) of the Department of Energy (DOE) is directing the program to disposition U.S. surplus weapons-usable plutonium. For the reactor option for disposition of surplus weapons-usable plutonium, MD is seeking to contract with a consortium, which includes a mixed-oxide (MOX) fuel fabricator and a commercial U.S. reactor operator, to fabricate and burn the MOX fuel in existing commercial nuclear reactors. This option would entail establishing a MOX fuel fabrication facility under the direction of the consortium on an existing DOE site. Because of the lead time required to establish a MOX fuel fabrication facility and the need to qualify MOX fuel for use in a commercial reactor, MD is considering the early fabrication of lead assemblies (LAs) under the technical direction of the consortium in an existing DOE facility. The proposed LA facility would be expected to produce a minimum of 1 metric ton heavy metal per year and must be operational not later than June 2003. DOE operations offices were asked to identify candidate sites and facilities to be evaluated for suitability for fabricating MOX fuel for LAs on this scale and time frame. MD tasked Oak Ridge National Laboratory (ORNL), as the technical lead for the reactor option, with the characterization of the suitability of the proposed sites.

Five DOE sites were identified as final candidates to host the LA project. The sites and principal fabrication facilities proposed at the sites are

1. Savannah River Site (SRS) H-Canyon,
2. Argonne National Laboratory-West (ANL-W) Fuel Manufacturing Facility adjacent to the Zero Power Physics Reactor,
3. Hanford Fuel Assembly Area (FAA) appended to the Fuels and Materials Examination Facility,
4. Lawrence Livermore National Laboratory (LLNL) Plutonium Facility-Increment 3 in the Superblock, and
5. Los Alamos National Laboratory (LANL) Plutonium Facility-4 in Technical Area-55.

The principal consideration for each of the options was to identify a suitable space for the powder handling, pellet fabrication, and rod loading processes. SRS, ANL-W, LLNL, and LANL proposed using space in operating facilities for the LA fabrication processes. Hanford proposed FAA, which was designed for MOX fuel assembly but has never been operational. Facilities for rod inspection and bundle assembly were given less consideration because requirements for these operations are less demanding, and most sites had multiple facilities that could be used for these processes. Suitable Safeguards and Security (S&S) Category I storage vaults for plutonium are available at all the proposed sites. All the sites have operating analytical laboratories for testing plutonium samples and would require varying amounts of project-specific analytical equipment to meet the needs of the LA project. All sites have suitable infrastructure to support the LA project, including facilities for handling transuranic wastes.

ORNL formed a Site Evaluation Team (SET) to determine the suitability of each site's proposed facilities and capabilities for fabricating MOX fuel LAs. SET developed guidelines to aid the sites' planning, toured the proposed facilities, and collaborated with each site in developing the site's proposal. SET evaluated the proposals from each site using 28 attributes grouped into 5 categories: (1) project-level, (2) operational, (3) safety-related, (4) safeguards and security-related, and (5) other. In its evaluation, SET compared the suitability of one site with another by attribute, but the team did not establish an importance weighting for the various attributes. The intention was not to rank the sites or to select one site over another. Determination of the relative importance of the attributes and consideration of other factors not evaluated during the SET review is within the purview of those who ultimately will select the LA host facility.

A summary of the SET evaluations of the options by the five categories of attributes is given here.

Project. The project-level cost and schedule attributes reflect the effects of the other 26 attributes on estimated cost and schedule. For this evaluation, the project is divided into four time phases: (1) preoperational, (2) operational, (3) standby, and (4) decontamination and decommissioning (D&D). SET estimated costs for each phase. The cost ranges by phase, summarized here by option, are expressed in millions of constant fiscal year 1998 dollars:

Option	Costs ($M)				
	Project total	Preoperational phase	Operational phase	Standby phase	D&D phase
SRS	76 to 80	35 to 37	31 to 33	8	2
ANL-W	72 to 81	29 to 33	31 to 35	10 to 11	2
Hanford	77 to 86	34 to 38	29 to 36	9 to 13	1 to 2
LLNL	67 to 82	29 to 36	28 to 34	8 to 10	2
LANL	65 to 75	17 to 21	36 to 41	10 to 11	2

The estimates show that each of the five options is economically viable. Given the absence of authoritative facility and process design requirements until the consortium is identified, caution is recommended in using these cost estimates to distinguish among the options. The ranges in cost represent the effects of specific indeterminate factors such as possible schedule improvement and labor rates that would be charged for the project rather than a measure of statistical uncertainty in the estimates or of project contingency.

A schedule acceleration of up to 12 months in advance of the June 2003 project milestone may be possible for the LANL option because of the potential use of an operating plutonium facility that has recently been used to make small amounts of MOX fuel for research and development purposes. However, this schedule acceleration could be negated if difficulties arise in the modification of this existing facility, which is contaminated, or if the facility layout desired by the consortium significantly differs from the existing layout. The opportunity for schedule acceleration for the other options appears to be less than that for the LANL option.

Operations. In the operational attributes, the primary differences among the sites were in the characteristics of proposed facilities for processing and experience in fabricating MOX fuel. All the sites except LANL and Hanford proposed installing all new process glove boxes and equipment in processing space that is isolated from other operations, is essentially free of contamination, and has few restrictions on the configuration of the process equipment. Hanford proposed installing all new glove boxes and equipment in an unused facility designed for MOX fuel fabrication. LANL proposed space within operating plutonium laboratories and the use of some existing operational glove boxes and processing equipment. The amount of space and supporting infrastructure of each candidate is adequate. Consortium options for process layout will be least constrained at Hanford FAA and most constrained at SRS and LANL.

The fuel fabrication and plutonium-oxide production experience of personnel at the sites evaluated varied significantly. Hanford, with its prior production of Fast Flux Test Facility (FFTF) fuel, has the most personnel with previous MOX experience. LANL, as the fabricator of MOX test fuel for MD and some FFTF fuel, has some personnel with current MOX experience. The other sites have some personnel with experience in fabricating other forms of nuclear fuel. Also, Hanford and SRS have personnel with experience in the large-scale production of plutonium oxide powders.

Safety. Only slight differences were noted in the safety-related attributes. Thus, no significant cost and schedule discriminators were attributed to this category of attributes. All the sites have proposed facilities that can meet the safety requirements for processing S&S Category I quantities of plutonium. LANL and LLNL, with currently operating plutonium facilities, would have to make only minor changes to their safety documentation. All candidate sites are addressed by the site-specific environmental impact statement being prepared under the direction of MD.

Safeguards and Security. In the safeguards and security-related attributes, the primary differences among the site options were in the amount of work needed to prepare the facilities for secure operations and the access to the processing facilities by visitors. Hanford FAA would need to upgrade and activate the perimeter and building security systems. SRS would need to install and activate security systems to upgrade the proposed area to S&S Category I status. Other options have most of the needed S&S provisions in place. Access controls for uncleared personnel would be stringent at any of the sites when S&S Category I quantities of special nuclear material (SNM) are present; however, the classified nuclear weapons work at some sites, especially LLNL and LANL, will require additional restriction of visitors. Before the required security features are activated, FAA could have the easiest access to the processing areas for installation of equipment and glove boxes. Access to the SNM storage vaults at all sites is comparable.

Other. In the other category of attributes, no significant differences among the sites were observed. The D&D cost and schedule were estimated to be approximately the same for all options. However, depending on the criteria in force when D&D occurs, significant differences among the options could emerge. Forecasting D&D criteria for facilities proposed for use in conjunction with these options was not within the scope of the SET evaluation.

The conclusion of SET is that each option evaluated can meet the requirements for the LA project. A detailed analysis performed by SET of the relative advantages and disadvantages of the options is provided.

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ABSTRACT

The Office of Fissile Materials Disposition (MD) of the Department of Energy (DOE) is directing the program to disposition U.S. surplus weapons-usable plutonium. For the reactor option for disposition of this surplus plutonium, MD is seeking to contract with a consortium, which would include a mixed-oxide (MOX) fuel fabricator and a commercial U.S. reactor operator, to fabricate and burn MOX fuel in existing commercial nuclear reactors. This option would entail establishing a MOX fuel fabrication facility under the direction of the consortium on an existing DOE site. Because of the lead time required to establish a MOX fuel fabrication facility and the need to qualify the MOX fuel for use in a commercial reactor, MD is considering the early fabrication of lead assemblies (LAs) in existing DOE facilities under the technical direction of the consortium. The LA facility would be expected to produce a minimum of 1 metric ton heavy metal per year and must be operational by June 2003.

DOE operations offices were asked to identify candidate sites and facilities to be evaluated for suitability to fabricate MOX fuel LAs. Savannah River Site, Argonne National Laboratory-West, Hanford, Lawrence Livermore National Laboratory, and Los Alamos National Laboratory were identified as final candidates to host the LA project.

A Site Evaluation Team (SET) worked with each site to develop viable plans for the LA project. SET then characterized the suitability of each of the five plans for fabricating MOX LAs using 28 attributes and documented the characterization to aid DOE and the consortium in selecting the site for the LA project. SET concluded that each option has relative advantages and disadvantages in comparison with other options; however, each could meet the requirements of the LA project as outlined by MD and SET.

1. INTRODUCTION

1.1 BACKGROUND

The Office of Fissile Materials Disposition (MD) of the Department of Energy (DOE) is directing the U.S. program to disposition surplus weapons-usable plutonium and is coordinating with the Russian government to proceed with similar efforts there. On January 14, 1997, DOE issued the record of decision (ROD) for the storage and disposition of weapons-usable fissile materials, including surplus plutonium. In the ROD, DOE announced the strategy of pursuing two options for dispositioning the surplus plutonium: immobilizing it in glass or ceramic and irradiating it as mixed-oxide (MOX) fuel in existing reactors. In pursuing the irradiation option, MD is seeking to contract with a consortium, which would include a MOX fuel fabricator and a commercial U.S. reactor operator. The plans include establishing a MOX fuel fabrication facility under direction of the consortium on an existing DOE site.

In the meantime, MD might choose to produce lead assemblies (LAs) of MOX fuel to support fuel qualification and other program objectives. MD is considering the use of an existing DOE plutonium facility to produce the LAs under the technical direction of the consortium, irradiating the LAs in a consortium reactor, and performing postirradiation examination (PIE) of the fuel at a DOE facility. The LA facility would be expected to produce a minimum of 1 metric ton heavy metal (MTHM) per year and must be operational by June 2003. Consequently, in June 1997, MD invited the DOE operations offices to participate in identifying DOE sites and facilities suitable for fabricating LAs of MOX fuel. MD tasked Oak Ridge National Laboratory (ORNL), as its technical lead for the reactor option, to work with the sites in developing viable plans and, then, to characterize the plans for suitability in making the MOX fuel.

In July 1997, ORNL formed the Site Evaluation Team (SET) and began to develop guidelines for the proposed LA facility, which was provided to the sites and is included as Appendix A to this report. In October 1997, SET completed visits to the six candidate sites and began to analyze data for eight options for the LA project that were collected during the site visits and provided by the sites following the visits. Then, in November 1997, SET provided each site team with a summary of the option's evaluation and conducted teleconferences to discuss the site comments.

In December 1997, MD selected five options for further evaluation and directed ORNL to prepare a report that addressed these options for conducting the LA project.

1.2 PURPOSE

The task of recommending and characterizing candidate sites and facilities for the LA project is intended to serve several needs. It identifies the best sites to host the LA project and characterizes the suitability of each; it gives the potential host sites an opportunity to present strategies for locating the LA project in their facilities; and it provides MD with rough estimates of cost and schedule to support program planning.

1.3 SCOPE

DOE operations offices identified six DOE sites as potential hosts for the LA project and participated in developing eight different options for fabricating the MOX fuel. MD directed ORNL to collaborate with various interested DOE and contractor personnel to develop the strongest possible options and then to characterize the suitability of each for performing the proposed LA project.

MD made preliminary evaluations of eight options and then selected five options for final evaluation. The final five options propose Safeguards and Security (S&S) Category I facilities at the Savannah River Site (SRS), Argonne National Laboratory-West (ANL-W), Hanford, Lawrence Livermore National Laboratory (LLNL), and Los Alamos National Laboratory (LANL). SRS proposed the use of an area within H-Canyon for the principal processes; ANL-W proposed the Fuel Manufacturing Facility (FMF); Hanford, the Fuel Assembly Area (FAA), adjoining the Fuels and Materials Examination Facility (FMEF); LLNL, the Plutonium Facility-Increment 3 (PF-I3); and LANL, the Plutonium Facility-4 (PF-4). The three options dropped from consideration were for non-Category I facilities at SRS, ORNL, and Hanford.

ORNL was directed to collaborate with the sites in developing viable options for the LA project and to provide information about the options that would aid MD planning activities and aid DOE and the consortium in selecting the site for the proposed LA project.

The ORNL task was to present data on suitability of the proposed facilities and infrastructure to conduct the LA project. The evaluation of events or decisions external to the execution of the LA project were beyond the scope of the task. The scope also excluded the audit of the candidate sites for items such as quality assurance, workload, financial processes, and regulatory compliance.

1.4 PROJECT PERSONNEL

MD directed this evaluation and requested that interested DOE operations offices identify points of contact (POCs) to support the effort. The candidate sites also identified POCs. These personnel are identified in Appendix B.

ORNL organized an evaluation team composed of persons with a wide range of skills. Each SET member has specific skills and specific assigned areas of responsibility; however, each member has broad experience and, on key topics, has collaborated with other team members with relevant experience to reach consensus. SET members, their areas of responsibility in the development of the site characterization for the LA project, and their experience summaries are included in Appendix B.

1.5 METHOD

MD tasked ORNL to survey the DOE sites for facilities suitable for fabrication of LAs to support the dispositioning of surplus weapons-usable plutonium. DOE invited each of the DOE operations offices to participate in the effort to identify a suitable facility and asked that they identify a point of contact to work with ORNL.

ORNL provided the DOE operations offices with criteria for identifying preliminary candidate sites and asked that the operations offices identify candidate facilities and associated contractor points of contact. The sites and their related DOE officials worked to identify qualified facilities that were able and willing to commit to the proposed project. Meanwhile, ORNL formed SET.

SET developed and provided the candidate sites with guidelines to aid in the development and evaluation of their plans. The guidelines, contained in Appendix A, include a baseline process description, material flow diagrams, lists of prototypical equipment, estimates of waste generation, baseline assumptions, and a questionnaire designed to aid in characterizing the options. Because the consortium is expected to provide technical guidance for the LA project, these guidelines were made solely for the purpose of providing a uniform basis to plan and evaluate the suitability of the candidate facilities, infrastructure, and experience to perform the LA project.

The sites, using the SET guidelines, developed preliminary plans for utilization of the facilities best suited for the proposed project. Meanwhile, SET developed a project template to aid in characterizing each option. The project template, consisting of 103 tasks under 15 subprojects, was intended to ensure that each option received the same thorough and systematic evaluation to reveal strengths and weaknesses and to provide rough-order-of-magnitude cost and schedule estimates for each option.

SET then visited with the contractor and DOE officials for each candidate site to tour the proposed facilities and discuss the plans for performing the proposed LA project there. These discussions were conducted in a collaborative manner and addressed subjects such as the plans for working with the consortium to design and modify the facilities; performing compliance activities [i.e., producing safety analyses, getting permits, evaluating National Environmental Policy Act (NEPA) constraints, and conducting readiness reviews]; installing and starting up equipment; defining and qualifying the processes; operating and controlling the fabrication processes; producing, certifying, and shipping the fuel; handling waste; maintaining the capability to produce additional fuel; and performing decontamination and decommissioning (D&D) operations after the LA project is completed. SET used these discussions to collect information needed to estimate the personnel and funding required to perform each of the 103 tasks in the project template. A sample of the data sheets used by SET to summarize the effort and resources required for each task is included in Appendix C.

Later, the site teams provided SET with written descriptions of their plans. SET collated the data from the site visits, the site answers to the questionnaires, and the site plans, and then summarized the planned efforts, including costs and schedule, for each option using the project template. Appendixes D–H contain final versions of the output from the project model for each option. The combination of the site identity and the acronym for the primary facility proposed for MOX processing identifies the models.

SET provided each site team with copies of the project model for their options and held teleconferences to obtain their comments and suggestions for improvement. All comments from the sites were addressed, and the project models were refined accordingly.

SET then characterized the strengths and weaknesses of each of the options using 28 attributes of suitability. These 28 categories include project-level attributes, operational attributes, safety-related attributes, safeguards and security-related attributes, and other attributes. Chapter 2 contains a discussion of the importance of each attribute and a brief comparison of the options. Chapters 3–7 contain a characterization of each option, including a discussion of how the option satisfies the expectations for each attribute.

1.5.1 Baseline Guidance and Questionnaires

SET developed guidance and baseline assumptions for the proposed LA project to save effort for the site teams and to permit fair comparisons of their options. The guidelines provided a description of the proposed project and constraints as outlined by MD, baseline assumptions for regulation of the LA project, project schedule, interface of the consortium with the site and DOE, processing and analytical operations including process flow diagrams and material flow rates, required processing equipment, and transportation of feed materials and finished fuel bundles.

SET also provided the sites with a questionnaire that was designed to have each site collect and document information on several relevant topics prior to the SET visit to tour the site and discuss proposed options. The detailed questionnaire, which is included in Appendix A, asked about site management, programs, and personnel; site infrastructure, services, and permitting status; and the physical, security, safety status, and programmatic characteristics of the proposed facilities.

1.5.2 Project Template

SET developed a project template, a computer-based model of a typical LA project composed of relevant milestones and 103 activities under 15 subprojects. A copy of the template is included in Appendix C. Project activities represented in the template begin with the selection of the host site and include the following:

1. collaborations by the consortium and host site to create conceptual process and facility designs for the proposed project,
2. design and modification of infrastructure and facilities,
3. procurement of equipment and materials,
4. acquisition of permits and performance of various analyses for safety and security,
5. definition and qualification of the processes,
6. performance of preoperational reviews,
7. operation of the processes and fabrication of the fuel,
8. maintenance of the processes and equipment in standby,
9. D&D, and
10. disposal of waste.

During the work sessions with each site, SET and the site representatives defined the work to be accomplished for each of the 103 activities and quantified the effort. For labor estimates, the types of personnel and the number of person-weeks of effort were estimated. Burdened costs were estimated for the procurement of materials and subcontracts for construction activities.

1.5.3 Cost Estimates

SET requested and obtained burdened labor rates for up to 22 job classifications for personnel whose efforts were identified in the project models. The labor rates supplied by the sites differed widely for similar job classifications. SET conferred with the sites in an attempt to understand the differences in labor rates and provide a fair comparison of the cost of the various options. Data representing the best resolution of the differences and the final input from the sites were utilized to create a reference case cost estimate.

After further study and comparison of the data for all options, SET identified several cost adjustment factors and computed their cost impact. These cost adjustments, some positive and others negative, were used with the reference case estimates to produce a cost range estimate for each option. These ranges should not be interpreted as estimates of statistical uncertainty.

The principal reasons for the difficulty in obtaining comparable labor-rate values from the various sites are understandable. The accounting methods of each site must comply with accepted methods mandated by DOE; however, each site has significant autonomy in structuring its work control and accounting systems to meet operational needs. Thus, computation of overhead that is added to base salaries varies from site to site. Also, some sites have DOE program sponsors who directly fund some operations that are paid for by overhead at other sites. In general, direct comparisons of labor rates, overheads, rents, and program taxes that affect the overall cost of a project are very difficult to make. SET considered all these variations and worked with site representatives in an attempt to fairly represent the cost expected for the respective options. The costs for each option are discussed under the Cost and Cost Risk attribute in Chap. 2 and Chaps. 3–7. Project model data are documented in Appendixes D–H.

The costs derived for the LA options are rough order-of-magnitude estimates of cost and should be treated as such. Persons who attempt to use the SET estimates presented in this report as predictors of cost for the LA project should consider two sources of uncertainty. First, the SET estimates were prepared from technical descriptions and guidelines, not designs. Second, the technical descriptions prepared by SET might differ from the requirements ultimately imposed by the selected consortium. However, the SET estimates, which are based on a detailed and uniformly applied process, are valid for their intended purpose—to provide MD with input for program planning and to ensure that the candidate options are within a reasonable range for further consideration. All costs are presented as unescalated fiscal year (FY) 1998 dollars.

1.5.4 Schedule Estimates

SET and the site teams discussed the durations to be used for the 103 tasks in the project template and relationships among the tasks during the same conference where effort and costs were discussed. SET entered data from these discussions into the project models for each option and generated the project schedule data.

SET focused most of its schedule deliberations on evaluating each option for situations that could cause the preoperational period to extend beyond the June 2003 milestone for producing the first qualified rod of MOX fuel. SET concluded that each site could meet the milestone date of June 2003. A concerted effort to optimize schedule could be performed on any of the options, and some improvements could be made in schedule performance for each. Also, SET briefly considered the likelihood of improving the schedule for each option and documented the results of those evaluations in the discussions of the Schedule and Schedule Risk attribute in Chap. 2 and in Chaps. 3–7.

2. SITE CHARACTERIZATION SUMMARY

2.1 OVERVIEW OF THE SITE OPTIONS

MD invited each DOE operations office to participate in identifying the best sites for fabricating LAs. MD charged ORNL, as the technical lead for the reactor option, to work with various interested DOE and contractor personnel to develop viable candidate plans for fabricating LAs and then to characterize the suitability of each.

MD directed ORNL to document the characterization of the following options: H-Canyon at SRS, FMF at ANL-W, FAA at Hanford, PF-I3 at LLNL, and PF-4 at LANL.

2.2 DESCRIPTION OF OPTIONS

The five site options are discussed in the order visited by SET. Additional descriptive materials for the candidate sites and facilities are contained in the data reports prepared by ORNL and the sites to support the site-specific environmental impact analysis performed under the direction of MD for the plutonium disposition program.

2.2.1 Savannah River Site

SRS proposed renovating an area in the H-Canyon facility that contains unused process modules from the Uranium Solidification Facility (USF) project, which was cancelled before the facility could be completed or used. The proposed H-Canyon site would house all the major operations for the LA project except for plutonium oxide (PuO_2) receipt and storage, which would be performed in the planned Actinide Packaging and Storage Facility (APSF), and selected laboratory analyses, which would be performed at the SRS Central Laboratory.

The APSF, to be located in F-Area and completed by September 2001, would receive and store PuO_2 powder until needed by the processing line. APSF will be an S&S Category I storage facility fully qualified to receive shipments of special nuclear material (SNM) by DOE safe secure trailer (SST). APSF will be able to accommodate the amount of material required by the LA project.

The MOX fuel fabrication processes would be housed in the inactive USF space, which consists of a 6000-ft^2, three-level space on two floors in Section 2 of H-Canyon. The USF process modules and equipment would be disassembled and removed; the processing space would be refurbished to accommodate the MOX process glove boxes and equipment. Ventilation systems would be upgraded. An existing in-process vault would be improved, instrumented, and hardened. The MOX process glove boxes and equipment would be installed, and access controls and other security systems would be installed to permit S&S Category I operation. An existing analytical laboratory would be renovated and devoted to MOX process analytical support. Access control, locker rooms, administrative space, and waste management activities would be shared with the existing H-Canyon B-Line (HB) organization. The space designated for use by the LA project is within an operational plutonium-handling facility that has active infrastructure suitable for supporting the fabrication of MOX fuel.

SRS would receive and ship fuel bundles from the dock located adjacent to the USF area.

The SRS Central Laboratory, located approximately 5 miles from the MOX process line, would back up the MOX analytical laboratory and provide other analytical tests as required.

2.2.2 Argonne National Laboratory-West

ANL-W proposed FMF and portions of the adjacent Zero Power Physics Reactor (ZPPR) and Fuel Assembly and Storage Building (FASB) to host the MOX fuel fabrication project.

PuO_2 powder would be received and stored at the ZPPR vault until needed by the processing line in FMF. The ZPPR vault and workroom are within an S&S Category I storage facility that is fully qualified to receive shipments of SNM by SST. The ZPPR vault can accommodate the storage of SNM required by the LA project.

The MOX process line would be located in FMF, an S&S Category I nuclear facility built to standards current in 1986 and designed for fabrication of uranium fuel and storage and handling of plutonium fuel to support the Experimental Breeder Reactor-II (EBR-II). ANL-W is upgrading FMF to current standards for processing plutonium. To prepare FMF for the MOX project, ANL-W would relocate the contents of the FMF vault into the existing ZPPR vault, remove racks and unneeded equipment, install MOX process glove boxes and equipment, and make minor upgrades to alarm and monitoring systems.

FASB, an S&S Category III radiological facility located adjacent to ZPPR, would be used for bundle assembly and inspection, bundle packaging, and receiving and shipping of bundles via SST or commercial vehicles. Few FASB modifications are needed.

Storage racks to be installed inside the ZPPR reactor shell would accommodate storage of multiple bundles.

The ANL-W chemistry and materials characterization laboratories, which are located near the FMF, would back up and supplement FMF analytical capabilities.

The ANL-W site has active infrastructure suitable for supporting the fabrication of MOX fuel.

2.2.3 Hanford

Hanford proposed the use of FAA for the LA project. In the plan provided to and evaluated by SET, FAA would house all the fuel fabrication operations for the LA project except for PuO_2 receipt and storage, which would be performed in the Plutonium Finishing Plant (PFP) vault, and selected laboratory analyses, which would be performed either at PFP or at Pacific Northwest National Laboratory (PNNL) analytical laboratories. Subsequently, Hanford proposed receiving PuO_2 shipments at FAA and storing the PuO_2 in the FAA tube vaults.

Under the plan evaluated by SET, the PFP vault would receive and store PuO_2 powder until needed by the processing line. The PFP vault is an S&S Category I storage facility fully qualified to receive shipments of SNM by SST. The amount of LA project material would be easily accommodated by PFP.

FAA is an inactive, largely self-sufficient, and essentially vacant facility that adjoins FMEF. FAA is an 18,000-ft^2 facility built for assembly of MOX fuel for the Fast Flux Test Facility (FFTF). FAA would be used for all MOX fuel fabrication operations, including shipping of the finished bundles. Few FAA modifications would be required to support the proposed LA project. Internal partitions would be constructed; a glove box ventilation system would be installed; a stack monitor and various safety and security alarm systems would be upgraded; and MOX process glove boxes and equipment would be installed and connected to utility services.

Some required analytical capabilities would be installed in FAA. PFP or PNNL analytical laboratories would back up and extend the FAA analytical capabilities.

The FAA physical security system is currently inactive; however, it was designed and constructed to permit FAA to operate as an S&S Category I facility. An inactive Perimeter Intrusion Detection and Assessment System (PIDAS) that would need to be upgraded and activated before operation encloses the FMEF-FAA complex. Otherwise, FAA and the Hanford Site have active infrastructure suitable for supporting the fabrication of MOX fuel.

2.2.4 Lawrence Livermore National Laboratory

LLNL proposed using space within two adjacent operating facilities, PF-I3 and the Hardened Engineering Test Building (HETB), both located within the LLNL Superblock security complex. Receipt, storage, and processing of powder and fabrication of pellets and rods would take place in the currently operating LLNL PF-I3, Building 332. PF-I3 is a section of PF built in 1977 to support the LLNL nuclear test program. Installation of rods into bundles, storage of bundles, and preparation of bundles for shipment would occur in the HETB Building 334, located adjacent to PF-I3.

PuO_2 powder would be received and stored in one of the active PF vaults until the processing line needs it. The PF vaults are fully qualified for receipt via SST and for storage of S&S Category I quantities of SNM and can accommodate the amount of material required by the LA project.

The principal MOX fuel fabrication processes would be housed in PF-I3 in S&S Category I space that contains unfinished, uncontaminated process modules originally intended for a cancelled laser isotope separation project. LLNL would remove the process modules and equipment, refurbish the processing space to accommodate the MOX process glove boxes and equipment, make minor upgrades to the ventilation systems, install glove boxes and equipment, and upgrade and reactivate an existing inactive security portal adjacent to the process area. The space designated for use by the LA project is within an operational plutonium-handling facility that has active infrastructure suitable for supporting the fabrication of MOX fuel.

Installation of rods into bundles, storage of bundles, and preparation of bundles for shipment would occur in HETB, located across the street from PF. To prepare HETB, a few pieces of equipment would be relocated and bundle assembly, inspection, and storage fixtures would be installed.

The existing PF analytical laboratories would support the MOX fuel fabrication process.

2.2.5 Los Alamos National Laboratory

LANL proposed using three existing facilities for the LA project. Technical Area (TA)-55/PF-4 would perform powder receipt, storage and processing, pellet fabrication, rod fabrication, and material characterization; TA-50/37, the Radioactive Materials Research, Operations, and Demonstration (RAMROD) facility, would perform rod nondestructive examination (NDE) and bundle assembly and inspection; and the Chemistry and Metallurgy Research (CMR) facility would provide analytical chemistry support.

PuO_2 powder would be received and stored in the PF-4 vault until required in the MOX fuel processing line. The PF-4 vault is fully qualified for receipt and storage of S&S Category I quantities of SNM and can accommodate the amount of material required by the LA project. PF-4 can accommodate SST shipments.

The principal MOX fuel fabrication processes would be located in an existing PF-4 processing area that contains glove boxes currently being used to fabricate limited quantities of MOX fuel for materials tests. LANL would modify the existing boxes as needed to install new process and analytical equipment, remove and replace glove boxes to accommodate the sintering and rod fabrication processes, and make other process changes that might be preferred by the consortium. Active utility services and the infrastructure suitable for supporting the LA project are in place. An existing caged area in the PF-4 basement would be expanded to provide for in-process storage of rods and bundles.

The RAMROD facility would require relocation of a few pieces of equipment and installation of rod and bundle inspection equipment and bundle assembly fixtures. No facility modifications are contemplated to upgrade security; rather, security forces would guard SNM when it is temporarily in the facility for inspections or assembly operations.

2.3 ATTRIBUTES SUMMARY

MD tasked ORNL to evaluate the suitability of each of the proposed options for performing the LA project. SET identified 28 attributes of a suitable facility and then evaluated how well each option satisfied the expectations for the individual attributes. Chapters 3–7 provide detailed discussions of each option and a characterization of its strengths and weaknesses as measured by the 28 attributes. The attributes, which are listed in Appendix C, are grouped into five categories: (1) project-level, (2) operational, (3) safety-related, (4) safeguards and security-related, and

(5) other. This section provides a description of the importance of each of the attributes to the LA project and a comparison of the options by attribute.

2.3.1 Project-Level Attributes

2.3.1.1 Facility and mission compatibility

Importance. Facilities proposed to support the LA project must be free of significant risk of conflicts with other proposed or ongoing activities for at least 10 years beginning in 1999. At least 3 years will be devoted to designing the process, preparing the facilities, installing special equipment, and qualifying the MOX fuel fabrication process and supporting infrastructure. After qualification, the process must remain intact and dedicated to producing relatively small amounts of prototypical fuel for 3 to 7 years.

Summary. Each site has indicated that the proposed facilities can be dedicated to the LA project with no significant risk of conflicts with other missions during the specified production and standby periods. The proposed area in the SRS H-Canyon facility is described as "surplus" and has no other foreseeable commitments. The ANL-W and related Idaho National Engineering and Environmental Laboratory (INEEL) facilities have no known conflicts. The Hanford FAA plan presented to and evaluated by SET stipulated the need for a compatible mission in the adjoining FMEF for the FAA option to be viable for the LA project. Subsequent to the SET evaluation, Hanford concluded that FAA is viable for the LA project, albeit at increased operating cost, even if a mission is not assigned for FMEF. Although FAA is also being considered for the fabrication of MOX fuel for FFTF in the timeframe of the proposed LA project, these activities could be relocated. The space proposed by LLNL has no known conflicting missions. LANL personnel indicated that they probably would use the glove boxes and perhaps the equipment for other undefined projects during the 4-year standby phase. In the event of national emergency involving the potential use of nuclear weapons, the LA project might be impacted by defense activities at LANL or LLNL; however, such an event also likely would cause reconsideration of the MD program strategy.

2.3.1.2 Cost and cost risk

Importance. Fabrication of prototypic MOX fuel for the LAs must be both timely and cost effective to achieve project success. The importance of estimated cost as a discriminating factor in the evaluation of the relative merits of the options depends, in part, on the range of cost estimates for the various options. The likelihood of cost and schedule estimate increases or decreases due to conditional factors or uncertainties should be considered when evaluating the options.

Summary. Each option was evaluated for cost using constant FY 1998 dollars and a standardized model composed of 103 tasks grouped under 15 subprojects. The model was designed to be consistent with the baseline guidance and assumptions described in Appendix A. The 103 tasks, listed in Appendix C, span the project life cycle, which is divided into four phases: (1) preoperational, (2) operational, (3) standby, and (4) D&D. The model includes the costs of labor and materials needed by the DOE site contractor to conduct the LA project under the direction of the consortium. Operating contractor activities include planning the program, preparing facilities, fabricating MOX fuel from qualified materials supplied by others to the candidate site, maintaining the facilities and processes in standby, and performing D&D at the close of the project.

SET collaborated with each site team to develop estimates of levels of effort and fixed costs for each of the 103 tasks for each proposed option. SET decided final values for effort and fixed costs for each option after touring the candidate facilities and conducting work sessions with personnel at each site. The final values for each option were documented in a reference case and provided to the respective sites for review. Areas of disagreement were discussed and resolved. The sites provided SET with values for labor rates and other economic data such as charges for space and services that applied to their respective sites. These reviewed data were input to form final reference cases of the project models for the options.

SET compared data from the candidate sites to ensure an equitable forecast of costs and to identify factors that might cause increases or decreases in the reference case estimates. SET examined the labor rates and space charges that had been provided by the sites and identified adjustments. The actual rates, overhead charges, rents, and numerous other factors affecting cost will be a matter of future deliberations among final candidate sites, DOE, and the consortium.

SET also determined cost adjustments to reflect savings from possible schedule improvements for each of the five options. The rationale for the schedule adjustments is presented in Sect. 2.3.1.3. Table 1 presents the reference case estimates and cost adjustments in millions of FY 1998 constant dollars.

Cost ranges that incorporate the reference cases and adjustment estimates by project phase are shown in Table 2. The overall range of cost estimated for the total project is from a low of $65M to a high of $86M. The estimates show that the five options differ, but all are economically viable. Given the absence of authoritative facility and process design requirements until the consortium is identified, caution is recommended in using these cost estimates to make significant distinctions among the options. Figure 1 presents the project total range and reference case estimates graphically. The adjusted cost estimate at Hanford is lower than the reference case estimate during the standby phase because of lowered overhead costs.

Estimates for the preoperational phase range from a low of $17M to a high of $38M. This large range represents the differences in work that must be expended at the various sites to prepare the facilities, equipment, and processes to produce the MOX fuel bundles. The preoperational phase average for the five options of $31M represents about 41% of the average estimated total project cost of $76M. Figure 2 presents the range and the reference case estimates for the preoperational phase. Sums of phase subtotals may differ from project totals because of rounding.

Table 1. Preliminary cost estimates for the MOX lead assembly project

Option	Cost ($M)			
	Reference case estimate	Space charges and labor rate adjustments	Schedule improvement adjustments	Other adjustments
SRS	75.9	4.5	-0.3	0.0
ANL-W	72.7	8.4	-0.8	0.0
Hanford	77.3	7.5	-0.3	0.8
LLNL	67.6	14.6	-0.7	0.0
LANL	65.6	8.9	-1.1	0.0

Table 2. Cost estimate ranges by phase for the lead assembly project

Option	Cost ($M)				
	Project total	Preoperational phase	Operational phase	Standby phase	D&D phase
SRS	76 to 80	35 to 37	31 to 33	8	2
ANL-W	72 to 81	29 to 33	31 to 35	10 to 11	2
Hanford	77 to 86	34 to 38	29 to 36	13 to 9	1 to 2
LLNL	67 to 82	29 to 36	28 to 34	8 to 10	2
LANL	65 to 75	17 to 21	36 to 41	10 to 11	2

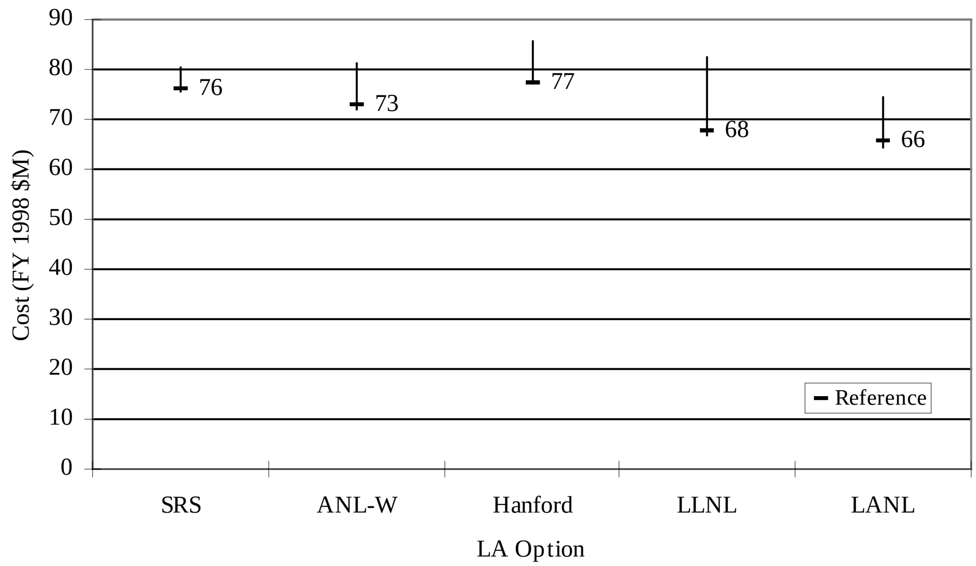

Fig. 1. Ranges of total estimated cost by option.

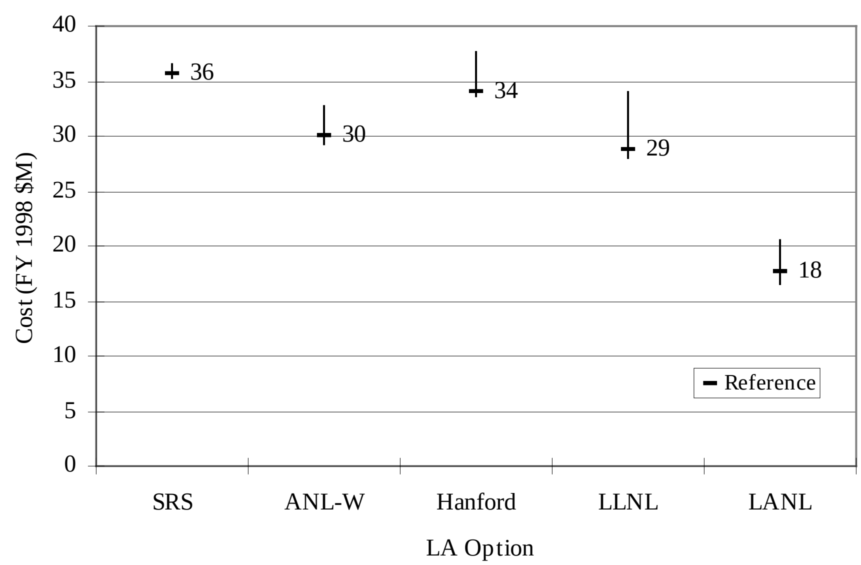

Fig. 2. Cost ranges during the preoperational phase.

Estimates for the operational phase range from $28M to $41M. This wide range reflects variations in the labor rates, space charges, analytical costs, and effort. The operational phase average for the five options of $33M represents about 44% of the total cost for the project. Figure 3 presents the range and the reference case estimates for the operational phase.

Estimates for the standby phase range from $8M to $13M. Labor rates and space charges are the principal reasons for the variation. The standby phase cost averages about 13% of the total cost for the project. The range and the reference case estimates for the standby phase are presented in Fig. 4.

Estimates for the D&D phase are approximately $2M for each option. This represents less than 3% of total cost for the project. Figure 5 presents the range and the reference case estimates for the D&D phase.

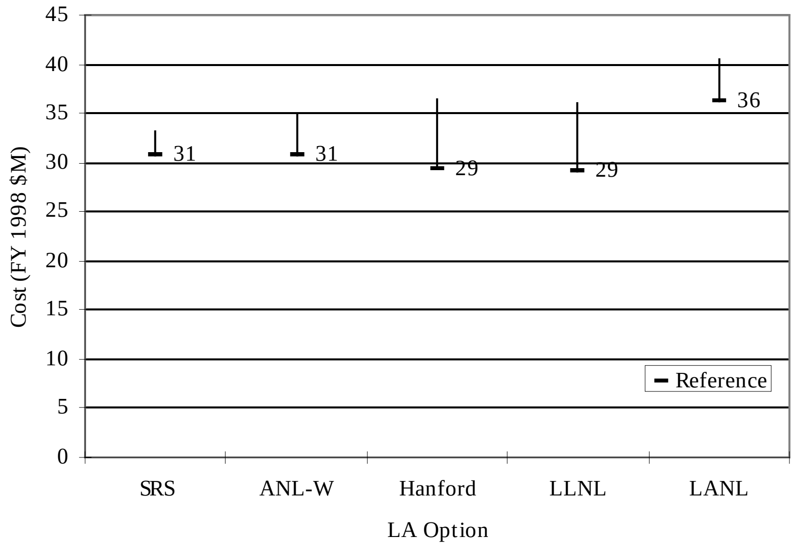

Fig. 3. Cost ranges during the operational phase.

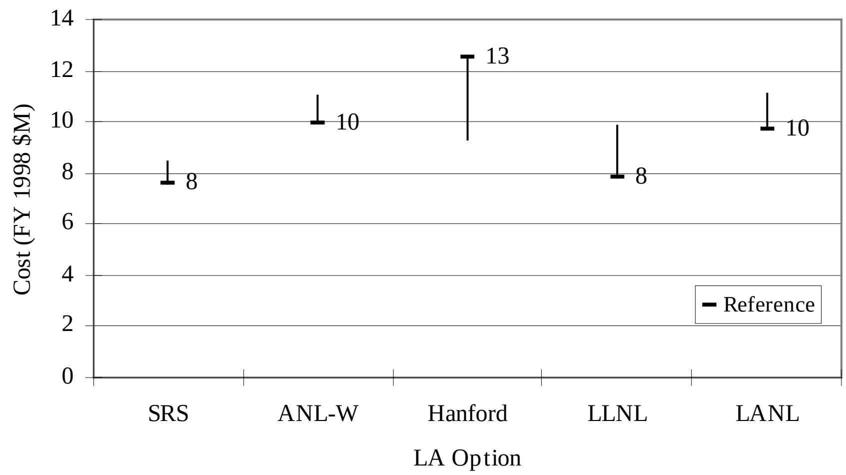

Fig. 4. Cost ranges during the standby phase.

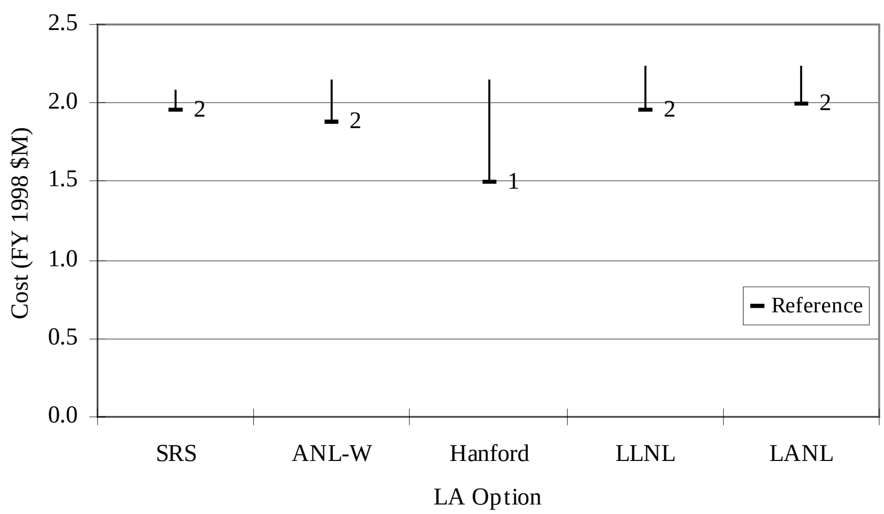

Fig. 5. Cost ranges during the D&D phase.

These estimates are suitable for developing estimated LA project costs for program planning purposes. Each site had input into these estimates, and these estimates are suitable for making rough comparisons among the proposed options. However, the final costs for this project will have to be determined by negotiations between DOE, the consortium, and the host site management and operating (M&O) contractor. In addition, the technical requirements necessary to implement fuel fabrication processes prototypical of those employed by the consortium may result in official estimates for project cost that differ significantly from these estimates.

The ranges in cost estimates presented in this section also are intended to show the effect of SET adjustments on the reference case estimates for LA project costs. These ranges should not be interpreted as a statistical measure of the uncertainty in the estimates. The process used to prepare the cost estimates was detailed, systematic, and consistently applied for each option. Designs for equipment, glove boxes, and process arrangement will be strongly influenced by the chosen consortium's requirements. Therefore, specific process designs were not prepared by SET or the sites as a basis for cost and schedule estimates. Thus, in the absence of design details, the cost estimates have significant uncertainties.

2.3.1.3 Schedule and schedule risk

Importance. A central premise behind the initiative to fabricate MOX fuel LAs within an existing DOE host facility is that such an option could obtain LAs significantly in advance of when they would become available from the MOX fuel mission facility. The existing MD planning basis is that an LA facility could start producing LA MOX fuel by June 2003, operate for 3 years, and remain in standby for an additional 4 years. In evaluating the relative merit of the five LA options, the likelihood of an option meeting, or exceeding, this schedule requirement would weigh heavily, and failure to meet the requirements for this attribute would jeopardize the viability of an option. However, because of the uncertainty resulting from factors listed previously (e.g., lack of a final facility design), small differences in projected schedule performance are not likely to be significant when evaluating the LA options. In addition, the likelihood of schedule estimate increases or decreases should be considered in evaluating the attractiveness of an option.

Summary. SET members collaborated with each site team to develop estimated durations for each of the 103 tasks in the LA project model at the same time the groups developed cost and level of effort estimates. The 103 tasks span the project life cycle from initiation of the project to decontamination and release of the facilities for other missions. These analyses show that all of the sites can meet the milestone date for producing the first qualified rod by June 2003.

The project schedules for each option assume that the LA fabrication site would be selected by January 1999. The first year of the project, 1999, would be devoted to developing a consortium-contractor working team, developing various facility and process plans, researching and resolving problems, preparing conceptual designs, and securing program funding. The next year would focus mainly on preparing detailed facility designs for modifications, beginning the removal of old process modules and equipment from the designated facilities, and acquiring specialized equipment. The next year would focus mainly on modifying facilities, installing glove boxes and process equipment, developing process control procedures, and assembling the operating staff. Then, the next 12 to 18 months would focus largely on checking out and starting up the equipment, training the operating personnel, qualifying fabrication and quality assurance (QA) process controls to ensure product quality and acceptability, conducting the readiness reviews, and fabricating the first qualified rod of MOX fuel.

The SET consensus is that a strong DOE contractor project management team and cooperative relationship with the consortium possibly could shorten this 4.5-year schedule. The likelihood of being able to significantly improve the schedule without sharply escalating cost is different for the various options because of unique situations at each facility. Personnel at one of the candidate sites observed that the organizational and regulatory complexity of the proposed project makes planning for a reduced preoperational phase duration for any option appear optimistic. All sites except LANL would have similar levels of work to acquire and install glove boxes and equipment. The space proposed by SRS is suitable for the MOX fabrication process but, because of its unique configuration, the space might be difficult to modify quickly and the MOX equipment and glove boxes may be difficult to install quickly. The spaces proposed by ANL-W and LLNL probably can be easily modified and new process items easily installed except for the challenges inherent in working under S&S Category I access controls. FAA at Hanford is nearly empty, is free of radioactive contamination, and has functional heating, ventilating, and air conditioning (HVAC) and fire protection systems. Preoperational activities at FAA would consist mainly of installing glove boxes, processing and analytical equipment, and security and material accountability equipment and then activating the equipment and demonstrating operational readiness for an essentially new facility. The LANL option is unique because most of the processing glove boxes already exist and are being used to make small quantities of MOX fuel for irradiation studies. The LANL option might require only two or three new glove boxes, minimal modification to others, and no substantial facility changes; thus, it appears to offer the best opportunity for early production of LAs. If the consortium finds the existing arrangement suitable for producing prototypic fuel, then LANL should be able to produce qualified LAs by June 2002.

SET estimated the schedule improvement for each option and computed the rent and overhead costs that could be saved by the reduction in the preoperational phase duration. The results are displayed in Table 3 and incorporated in the cost ranges presented in Sect. 2.3.1.2.

SET did not attempt to gauge the effect of events or decisions external to the execution of the LA project.

Table 3. Estimated schedule improvement

Option	Preoperational phase duration reduction (months)	Preoperational phase cost reduction ($M)
SRS	4	0.3
ANL-W	6	0.8
Hanford	2	0.3
LLNL	9	0.7
LANL	12	1.1

2.3.1.4 Quality assurance program

Importance. MOX fuel LAs must be fabricated under controlled, repeatable conditions that comply with consortium and Nuclear Regulatory Commission (NRC) QA requirements. The LA project must demonstrate to NRC and the consortium that its QA program ensures that all activities affecting the quality of the LA fuel are conducted such that the requirements stated in Title 10 *Code of Federal Regulations* (CFR) Part 50, Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” are satisfied. Inadequate QA implementation will result in delay to the LA project. The LA project host site can expect QA personnel from the consortium to provide substantial input in establishing and implementing a QA program. However, the ultimate responsibility for ensuring that an adequate QA program is in place for the LA project belongs to the host site.

Summary. Each candidate site has a QA program that complies with DOE QA requirements. From time to time, some sites have adjusted various elements of their QA program to meet the specific requirements of other governmental or commercial customers. However, only one organization, one of the Hanford contractors, indicated that it has recent, direct experience in producing a limited quantity of reactor hardware to NRC QA requirements. The other organizations acknowledged the importance of having a robust QA system, but it was not apparent that all sites were equally qualified to achieve the required level of QA performance with reasonable effort. However, an audit of the potential host sites’ QA programs was not within the scope of the SET evaluation and is an exercise that would have required several weeks effort at each site. SET concluded that sites tended to underpredict the effort required to achieve an adequate QA program. Sites having little recent experience in sustained production of precise hardware to tightly controlled processes are likely to encounter relatively greater challenges in establishing an adequate QA program. Research and development (R&D) experience at the defense laboratories likely will give them an advantage in maintaining QA standards for carefully controlled experiments and production of samples, but not for QA standards related to sustained production of hardware to a controlled process. ANL-W, Hanford, and SRS probably have a relative advantage over other options with regard to satisfying QA requirements for the LA project.

2.3.2 Operational Attributes

2.3.2.1 Production-processing approach

Importance. As addressed in Sect. 2.3.1.4, the MOX LA fuel must be produced in a controlled and repeatable process and must be sufficiently similar to MOX fuel produced at the full-scale MOX fuel fabrication facility. Otherwise, the noted behavior of LAs in the reactor tests and results of PIE will be compromised as indicators of expected performance of the mission fuel.

Summary. SET concluded that each site probably would be able to satisfy the consortium's requirements for establishing a prototypic process, including consideration of characteristics and operation of process equipment, batch size, in-process controls, and QA measures. The facilities proposed by SRS and LANL have less flexibility than others to adapt to the specific layouts that may be preferred by the consortium.

2.3.2.2 MOX fuel fabrication experience

Importance. Together the consortium and the host site must have the skills and experience to quickly and efficiently establish the process and produce prototypical MOX fuel for the LA project. The consortium is expected to provide the technical and process expertise necessary to define and establish the fabrication process and to deal with NRC regarding licensing issues. The quality of the product and the resulting cost and schedule for its production could be adversely impacted if the host site is inexperienced in the following specific skills: proficient handling of PuO_2 powders; designing and modifying facilities and glove boxes for processing PuO_2; dealing with all facility-related regulatory issues; and running a tightly controlled, pilot-scale manufacturing process. The site also must have personnel who can work effectively with the consortium to define and qualify the process and supporting infrastructure. Sites with recent, positive experience producing MOX fuel would have an advantage over sites with no experience in producing MOX fuel.

Summary. Each of the site options has strong and weak points on the relevant experience discussed previously. Each site has experience in the design, installation, and sustained operation of plutonium processes that comply with applicable state and federal regulations. SRS has more than 30 years experience in fabricating metallic reactor fuel, has PuO_2 production experience, and has some personnel with MOX experience; however, the site has not produced MOX fuel. ANL-W has not produced MOX fuel; however, it has a long, successful record of conducting fuel research and fabricating fuel for various DOE reactors. Hanford has experience with reactor fuel and PuO_2 production and has produced significant amounts of MOX fuel, but not recently. There are several personnel at Hanford with MOX experience, including commercial fuel fabrication. One of the Hanford organizations has recent experience in making targets for irradiation in a NRC-regulated commercial reactor. Both LLNL and LANL personnel have experience in the successful, sustained operation of a plutonium facility, but their operations are focused on R&D, not hardware production. LLNL has not produced MOX fuel. In the past, LANL has produced uranium nitride (UN) fuel for a space reactor and MOX fuel for the FFTF reactor. Recently, LANL produced small quantities of MOX fuel for MD-sponsored irradiation studies.

2.3.2.3 Prototypic process equipment

Importance. If the LA project is to support the MOX fuel qualification efforts, it is imperative that the LA fuel be representative of the mission fuel. Producing the LA fuel using prototypical processes and equipment is the best way to ensure that the LA fuel is representative of the mission fuel. The consortium that will produce the mission fuel will also provide technical direction for the production of the LA fuel and is expected to mandate the equipment requirements regardless of which site is hosting the work.

Summary. In general, the sites do not have prototypical equipment for the bulk processing of powders, pressing and sintering pellets, filling and welding rods, or assembling rods into bundles. LANL has pellet presses, a centerless grinder, and many of the glove boxes needed for the powder and pellet processes. Hanford has several pieces of uncontaminated equipment: a V-blender, pellet press, debinding and sintering furnaces, laser gauge, and centerless grinder from an unoperated MOX fuel fabrication line. It is uncertain whether the equipment at either Hanford or LANL would be considered sufficiently prototypical by the selected consortium. However, SET concluded that the cited equipment at LANL is operational and of the size and design that might be found by the selected consortium to be adequate to support the LA project, while the Hanford equipment is designed to accommodate much larger material flows and fuel with much higher plutonium content than the LA fuel. All of the sites have some of the necessary analytical equipment, and all plan to procure additional analytical equipment. LANL has all the required analytical equipment but would purchase a few backup items. The site that already has prototypical equipment and the supporting infrastructure in place will have to spend less project funding to acquire and place the requisite prototypical equipment into operation. However, no site should be excluded for not having prototypical equipment, because the missing items can be acquired within the needed time and the added cost already has been incorporated into reference cost estimates.

2.3.2.4 Batch size flexibility and analytical optimization

Importance. Feed material “lots” and processing “batches” are two separate, but related production factors that could significantly affect the inherent uniformity and acceptability of the MOX pellets and the overall cost of analyses needed for process control and product certification.

The size of incoming lots of PuO_2 and depleted uranium oxide (DUO_2) and the lot-to-lot variations in properties depend on the processes and specifications for producing the materials. The DUO_2 probably would be provided from conventional, well-characterized processes in large, uniform lots. The characteristics of the PuO_2 powder from the pit disassembly and conversion (PDAC) process would be established though R&D efforts that are currently under way. A material conditioning step may need to be added at the site of PDAC demonstration projects that are expected to provide PuO_2 or at the beginning of the MOX fuel process at the LA site to provide PuO_2 feed with properties and uniformity suitable for producing MOX fuel.

The size of MOX powder batches will affect the cost and uniformity of the MOX fuel. In general, MOX fuel produced in a few large batches will be more uniform and cost less than when produced in numerous smaller batches. For example, doubling the batch size will roughly halve the analytical costs necessary to support process control and product certification.

It is expected that most pellets would be produced to a single, nominal plutonium concentration (nominally 5%). Smaller production runs of MOX pellets having other plutonium concentrations (all under 10%) also are expected to be required.

Summary. Determining the size for MOX powder batches is an important process design decision that will be based on consideration of factors such as product throughput requirements, criticality, and other safety limits for PuO_2 processing, S&S, process yield, and economics. This decision would be made ultimately by the consortium. Each of the candidate sites can accommodate both reasonably large batches suitable for the typical production runs and small batches for limited runs at various plutonium concentrations. Some sites have tentatively set the maximum size of MOX batches at 100 kg. Others indicate a preference for larger MOX batches up to 200 kg. Each candidate option appears to be able to satisfy the consortium's preferences for batch size.

2.3.2.5 Characteristics of proposed facilities for processing

Importance. The facility hosting the LA project must be able to accommodate the processing and equipment preferences of the consortium, which would provide technical direction of the LA project. The fuel must be prototypical of anticipated fuel from the MOX mission facility. The consortium is expected to specify process techniques and equipment that utilize its European experience base in fabricating MOX fuel for both LAs and mission fuel.

Summary. All sites proposed facilities that can accommodate prototypical powder, pellet, and rod processing equipment that the consortium is likely to specify. The sites differ in their capabilities and approach to integrating the unit processes into a prototypical line. Most options offered processing areas that have little or no radioactive contamination, have few constraints on arrangement of the process elements, would use new glove-box enclosures designed for most of the specified process equipment, and permit arrangement of the process elements into process flow configuration. The LANL option calls for the powder and pellet processes to be performed in existing glove boxes and some existing equipment items in an operating plutonium laboratory. The space proposed in the SRS option has spatial characteristics that likely would make process layout and installation difficult but may offer a slight advantage if vertical processing of the powder is preferred by the consortium. The Hanford FAA is spacious and essentially new and provides the most flexibility for installing the LA process. The LLNL and ANL-W options offer suitable facilities with adequate space.

The facilities proposed by the sites for bundle assembly had sufficient ceiling height and space to accommodate the bundle assembly operations.

Each site has proposed space that probably can suitably house the processes and equipment that the consortium likely will specify. The time and cost to make the facilities ready for production will depend on the specific preferences of the consortium.

2.3.3 Safety-Related Attributes

2.3.3.1 NEPA compliance

Importance. MD is preparing a site-specific environmental impact statement (EIS) that is intended to be sufficient for conducting the LA project at any of the candidate sites without further NEPA actions. It is anticipated that any site selected would need to prepare supporting documentation to ensure that the final process and facility designs are within the EIS bounding analyses. Additional NEPA action, if required, would increase project cost and could delay the project.

Summary. The site-specific EIS being prepared by MD is expected to afford ample margins for the design of efficient processes that would have acceptable environmental consequences. All facilities would need to demonstrate that the process finally specified is within the EIS envelope. If it is determined that this is not the case, additional NEPA action might be required to extend the boundary or the planned process might need to be adjusted to comply. Consortium requirements for the process design are not expected to push the process definition beyond the limits of the EIS, but confirmation of this would be necessary. Conversely, the EIS is not expected to overconstrain the process design.

2.3.3.2 Safety bases

Importance. The LA project is to be conducted in a DOE facility under DOE regulation. Each of the proposed facilities must have or be capable of qualifying as a Hazard Category 2 nonreactor nuclear facility. Under DOE Orders, this requirement applies to any facility where the inventory of radioactive material exceeds a specified limit; for plutonium the limit is 450 g.

Further, DOE Orders require that a designated nonreactor nuclear facility must document its safety basis. Currently, acceptable safety basis documentation consists of a safety analysis report (SAR) in the format specified in DOE Order 5480.23 and technical safety requirements (TSRs) that comply with DOE Order 5480.22. During the transition from previous safety documentation requirements to the current requirements, many DOE sites operated under basis of interim operations (BIO) documents. Some sites still operate under BIOs. A summary of the site safety bases is contained in Table 4.

It is important that the host site ensure effective compliance with the processes that DOE uses to ensure safe operations. The facilities hosting the LA project would be under scrutiny from the consortium, NRC, DOE, the Defense Nuclear Facility Safety Board (DNFSB), and the public. Under this scrutiny, incidents would be magnified and have the potential for causing project delays. The host facility, not the consortium, would bear the responsibility for ensuring safe operations.

Table 4. Summary of current and proposed safety bases and documentation

Option	Hazard category		Safety basis documentation		Comments
	Current	Proposed	Current	Proposed	
SRS	2	2	BIO	BIO	SRS plans to amend BIO and not upgrade to DOE 5480.23 format
ANL-W	2	2	FSAR	5480.23	New DOE 5480.23 SAR may be approved by 1999
Hanford	None	2	PSAR	5480.23	New DOE 5480.23 SAR to be prepared
LLNL	2	2	5480.23	5480.23	Approved DOE 5480.23 SAR and TSRs in place
LANL	2	2	5480.23	5480.23	Approved DOE 5480.23 SAR and TSRs in place

Another factor involves the inferences NRC might draw from the host facility's safety basis and implementation. The NRC must be convinced by the consortium's reactor owner that placement of the LA MOX fuel in the reactor has acceptable safety consequences. NRC is expected to be present in the LA facility before and during fuel fabrication to ensure that the fuel quality is known and acceptable. NRC's observation of good safety documentation and practices in the host facility undoubtedly would contribute positively to its assessment of fuel quality. Conversely, NRC's observations of inappropriate safety likely would have negative consequences on judgments of adequacy of other important matters.

Summary. Most of the proposed facilities currently are designated as Hazard Category 2 nuclear facilities. FASB at ANL-W, FAA at Hanford, and RAMROD at Los Alamos are nonnuclear facilities that would be reclassified as Hazard Category 2 nuclear facilities. PF-4 at LANL and PF-I3, Building 332, at LLNL currently have new DOE 5480.23-format SARs and TSRs in place. The RAMROD facility SAR is being prepared to the DOE 5480.23 format and would then be amended for bundle assembly activities. SRS has a BIO document and has not committed to preparing a DOE 5480.23-format SAR for the 221-H Canyon facility before LA project startup. ZPPR, FMF, and FASB at ANL-W would have SARs and TSRs updated to the DOE 5480.22 and 5480.23 formats. FAA at Hanford would prepare a new DOE 5480.23-format

SAR from draft preliminary safety analysis report (PSAR) documents originally prepared during FMEF construction.

2.3.3.3 Operational readiness review

Importance. The host facility for the LA project will be DOE-regulated. Consequently, an operational readiness review (ORR) must be performed in accordance with "Startup and Restart of Nuclear Facilities," DOE Order 425.1. This process requires self-assessment, contractor-independent assessment, and, if warranted, review by a DOE team. Some sites indicated that their facilities that are currently operating and handle uranium might need only a readiness assessment to initiate "cold startup" with uranium. Other sites indicated that the complete ORR would be required before introduction of any radioactive materials into the proposed MOX fuel fabrication line.

Summary. Each site has processes and trained personnel for satisfying the requirements of DOE Order 425.1. ORR for the proposed LA processes at facilities currently approved for plutonium processing (e.g., SRS, LLNL, and LANL) would be performed more quickly and easily that an ORR at facilities not currently approved for processing plutonium.

2.3.3.4 DOE Order compliance

Importance. The LA project will bring the host site considerable scrutiny from several sources. For the project to be successful, the host site and especially the MOX facility must demonstrate well-controlled operation in compliance with DOE regulation. DOE, DNFSB, NRC, and the consortium members would scrutinize almost any facet of operation. The appearance of a lack of rigor in compliance with DOE requirements might embarrass the program, cause cost and schedule impact, and increase the depth of oversight that other agencies might impose on other parts of the program.

Summary. All sites declare compliance with relevant DOE Orders and other requirements. However, rigorous assessment of the degree of compliance of the sites to relevant requirements would have taken several weeks at each site and thus was beyond the both the scope and means of SET. Some of the offered facilities were inactive, and others were operating, thus thwarting direct comparison. It is pertinent to note that active plutonium-processing facilities appeared to have a substantial investment in standardized, proven practices that would be difficult, expensive, and time-consuming to develop where none exists. Consequently, facilities and sites that have not been operating as plutonium facilities might have difficulty establishing and qualifying all necessary conditions and practices to demonstrate compliance with DOE requirements for the limited size and scope of the LA project. Unanticipated costs to achieve equivalence may be large in comparison with other options and the overall project scope.

2.3.3.5 Compliance with plutonium-processing and -handling facility design criteria

Importance. The proposed MOX fuel fabrication facility will handle kilogram quantities of PuO_2 powder. Facility and system design that provides adequate safety features and redundancy is necessary to demonstrate commitment to safe operation of plutonium-processing facilities.

Summary. Each of the candidate facilities either was designed to DOE Order 6430.1A, which imposes requirements for plutonium-processing and -handling facilities (PPHF) and confinement systems, or has addressed PPHF issues via self-assessments, modifications, or inclusion of equivalent protections in its safety basis. The SRS, LLNL, and LANL teams, which proposed using facilities that are currently approved for processing of plutonium, indicated that the PPHF features of their respective facilities would require only minor changes to accommodate the proposed LA project. ANL-W indicated that the planned modifications would be performed and ensured to comply with PPHF criteria through the safety analyses and preoperational reviews that are required and planned. FAA, which was designed to PPHF standards, will require a few minor upgrades. The costs of modifications and assurance activities are included in the reference cost estimates.

2.3.4 Safeguards and Security-Related Attributes

2.3.4.1 Physical protection

Importance. DOE requires the systematic protection of items such as facilities, vital equipment, classified matter, and, especially, SNM. Physical protection consists of a number of components that detect, delay, and respond to adversary attack. The components are applied in a graded manner and in proportion to the importance for protection.

Summary. All sites would require some physical protection upgrades, and most of the sites would need some additional security force personnel. The largest requirements for additional security force personnel are for access control and to provide additional short-term protection of SNM. A summary of the physical protection upgrades and added security personnel is provided in Table 5. LANL personnel indicated that they would use existing security personnel to provide the needed security at RAMROD.

Table 5. Physical protection

Option	Security force added	Physical protection upgrades
SRS	9	Upgrades needed in USF area to include detection, delay, surveillance, contraband, and access control
ANL-W	2	Some minor upgrades in FMF and ZPPR, with most upgrades needed in bundle assembly area located in FASB
Hanford	13	Upgrade FAA S&S systems, including access control, detectors, assessment, and barriers, and activate the PIDAS and protected area portal systems
LLNL	6	Some minor upgrades in bulk processing and bundle assembly areas, with most upgrades needed to activate a portal
LANL	0	No significant upgrades needed in PF-4 and only minor upgrades needed in RAMROD

2.3.4.2 Material control and accountability

Importance. Nuclear material must be controlled and accounted for in a graded manner consistent with its importance. The material control and accountability (MC&A) system must provide an accurate accountability of the nuclear inventory, control of the nuclear material, and assurance that the material has not been diverted or stolen. The MC&A systems include a number of different components to encompass nuclear measurements, material control, and material accountability. Effective MC&A systems must exist for the MOX fuel fabrication activities to be performed.

Summary. All of the sites need a rod scanner, and standards would also be needed at most of the sites. Some of the sites have all other necessary destructive assay (DA) and nondestructive assay (NDA) capabilities, while others would need most devices. Some NDA devices would be needed to directly support the bulk processing activities and ideally should be collocated near the processing areas. For those sites having NDA capability, it usually exists at nearby analytical support laboratories or because of other nearby PuO_2- or SNM-related activities. Most of the sites have not done a preliminary MC&A assessment to analyze the material flow and identify the necessary material accountability measurements and material balance areas (MBAs). One site has done a very extensive MC&A preliminary assessment. Some of the sites would need additional personnel to support the MC&A activities. Depending on the site, either these additional MC&A

personnel or other MOX operations personnel would perform necessary duties such as material accountability or vault custody. A summary of the MC&A upgrades and additional MC&A personnel is given in Table 6.

Table 6. Material control and accountability

Option	MC&A planning and upgrade status	NDA equipment needed	MC&A personnel added
SRS	No preliminary plan, no MC&A capability at MOX fabrication areas	All NDA equipment, rod scanner	1
ANL-W	No preliminary plan, most MC&A capability exists	Rod scanner	2
Hanford	No preliminary plan, no MC&A capability at MOX fabrication areas	All NDA equipment, rod scanner	2
LLNL	Preliminary plan, most MC&A capability exists	Rod scanner	3
LANL	MC&A plan for MOX activity exists, most MC&A capability exists	Rod scanner	0

2.3.4.3 Vulnerability assessment and site safeguards and security plans

Importance. Each site must have a vulnerability assessment (VA) and a site safeguards and security plan (SSSP) to ensure the security of SNM from theft, diversion, or sabotage. It is envisioned that all of the MOX fuel fabrication activities, including processing of bulk powders and pellets, rod fabrication, bundle assembly, and transport, would be subject to VA that would consider possible threats for theft or diversion of SNM or sabotage. The VA would identify needed upgrades to the S&S systems and procedures, which then would be addressed in a revision to the SSSP. The MOX fuel fabrication activities would not be allowed to start until DOE has approved the SSSP.

Summary. Some of the sites have conducted a preliminary VA for the proposed MOX fuel fabrication operations. The impact of the MOX operations on existing VA and SSSP depends on existing operations at the specific locations. If the target material for MOX is less attractive or the quantities are less than those that currently exist, then the impact of the proposed MOX operations would be minimal. This is the case for four of the options: SRS, ANL-W, LLNL, and LANL.

2.3.4.4 Radiological sabotage potential

Importance. An assessment of the radiological sabotage (RADSAB) and subsequent potential dispersion of SNM is an important consideration for all sites. The results of the VA would likely limit the quantities of SNM at a given location for several of the options. This attribute directly affects batch size and the issues associated with batch size.

Summary. Some sites have performed analyses to assess the potential for sabotage and dispersion of PuO_2 and have established limits for “available” or “at-risk” PuO_2. Others have made preliminary estimates based on other site activities. These analyses appear credible and show that RADSAB-based restrictions do not impose unreasonable processing constraints on any of the proposed options.

2.3.4.5 Access by foreign nationals and uncleared personnel

Importance. Access by foreign nationals and other uncleared personnel to the facilities proposed for the MOX fuel fabrication processes likely would be necessary to proceed with the consortium-guided LA project as planned. Frequent visits and, at times, constant presence are expected in secure facilities by consortium or other uncleared personnel. Access will be required to facilities with various levels of control, including property protection areas (PPAs) in which uncleared personnel may work without escort, and limited areas, protected areas (PAs), and material access areas (MAAs) where escorts for uncleared personnel are required.

Summary. The visits may impact other projects. Visits to highly protected areas by uncleared persons or foreign nationals may impact other operations and increase security requirements if classified or other sensitive activities are ongoing near the proposed MOX operating areas.

Some LA project activities performed in highly protected areas may be impeded or made more expensive than at sites where preoperational phase activities can be performed under lower levels of security. At a minimum, visits by uncleared persons or foreign nationals to highly protected areas, either PA or MAA zones, would require additional effort to acquire access authorization approval and to satisfy escorting requirements. Preoperational preparation of the proposed MOX areas currently located in a PPA could be done more inexpensively and efficiently than for those options that require the work to be done in highly controlled PAs. Savings would come from efficient access for consortium representatives, construction contractors, equipment specialists, and consultants, and from not having to pay for extra security personnel during the facility modification period.

Few visits by uncleared people would be required for vault operations involving storage of bulk quantities of PuO_2. All of the sites would receive and store PuO_2 at an operating vault. It is envisioned that these areas would not be of particular interest to consortium personnel or other personnel related to the LA project. Routine visits by uncleared persons would be unlikely, but occasional visits may be necessary.

Bulk powder processing and rod fabrication operations at each site are proposed for facilities where security during the preoperational phase would range from the low security level of PPA to the high security of an MAA. These operations most likely would be the focus of attention of the consortium and probably would need to be accessed also by other uncleared persons such as NRC representatives, construction personnel, equipment specialists, and consultants.

Bundle assembly operations are proposed for facilities where security during the preoperational period ranges from PPA to PA. These operations would be of occasional interest to consortium personnel and may require access for brief periods by construction, equipment, and consulting personnel.

During the operating period, consortium representatives and NRC personnel are expected to be present routinely where MOX processing is being performed.

Table 7 summarizes the expected security levels and likely presence of other sensitive materials requiring protection for the various LA project options. LANL and LLNL have sensitive material present that would have to be protected from access by uncleared persons. LLNL plans to remove classified material from the PF-I3 facility. Hanford does not now have any classified material in FAA or the adjoining FMEF. However, some of the FMEF uses will involve classified material. SRS has some classified material in H-Canyon but not in the area proposed for the LA project. ANL-W has no classified material in the FMF facility.

Table 7. Access by foreign nationals and uncleared personnel

Option	Classified/sensitive matter to protect	Security level during preoperations	Security level during operations
SRS	No	PA	MAA
ANL-W	No	PA and PPA	MAA and limited area
Hanford	No	PPA	MAA and PA
LLNL	Yes	MAA and PA	MAA and PA
LANL	Yes	MAA and PPA	MAA and limited area

2.3.4.6 Special nuclear material storage

Importance. PuO_2 powder, MOX powders and pellets, MOX rods, and MOX bundles must be stored and protected in an appropriate manner. Graded safeguards provisions would apply based on the category and attractiveness level of the SNM to be protected. PuO_2 and 30% MOX powders and pellets are designated as attractiveness level C. MOX blends, rods, and bundles with 10% or less plutonium are designated as attractiveness level D material.

The category designation is based on the quantity of plutonium present. For attractiveness level C material, 6 kg or more of plutonium is Category I, and 2 kg or more but less than 6 kg of plutonium is Category II. For attractiveness level D material, 16 kg or more of plutonium is Category II, and 3 kg or more but less than 16 kg of plutonium is Category III. It is not possible to have Category I quantities of attractiveness level D material. Also, it is not possible to combine quantities of attractiveness levels C and D material to attain a higher category level.

Summary. Each site has made a preliminary determination of the SNM storage requirements for each of its processing steps and discussed them with SET. The planned S&S category designations are consistent with the respective process descriptions and with the applicable DOE requirements for SNM storage.

Each site proposes to receive and initially store the PuO_2 within an operational S&S Category I vault that is qualified for storage of PuO_2. SRS plans to use a new vault that is expected to be in service in time to support the LA project. Other sites plan to use existing vaults. All vaults would have adequate capacity needed to support the LA project.

SNM storage requirements would change when the PuO_2 is moved to the process areas, mixed to varying concentrations with DUO_2, and then contained within the sealed structures of fuel rods and bundles. Each option plans to have the capability to process S&S Category I quantities of PuO_2. In some cases the bulk material would be stored in process-line glove boxes and in other cases would be stored in vaults. After the initial processing, the PuO_2 will be combined with DUO_2. After this dilution, the allowable quantities of material that can be present for a given S&S category can increase substantially depending on concentration, form, and other factors too complex to permit generalization. Although it is possible to perform the MOX processing in an S&S Category II or III facility, the operation would be complicated by the need for careful control of the amount of in-process material and potential extra movements of material between the vault and processing areas.

2.3.4.7 Other safeguards and security characteristics

Importance. DOE requires that personnel with hands-on access to Category I quantities of SNM possess an active Q-clearance. A Q-clearance also is required for hands-on access to Category II SNM that can be rolled up to Category I. Personnel with access to Category II and III quantities of SNM must have at least an L-clearance. DOE requires consideration of insider risk in handling SNM and, when appropriate, enrollment of select groups of personnel in the Personnel Security Assurance Program (PSAP). In addition, the site must have other S&S programs such as operational security (OPSEC), technical surveillance and countermeasures (TSCM), and computer security that are designed to meet the security needs of the operations.

Summary. All sites have cleared personnel and the applicable security programs mandated by DOE for the control of SNM and other security measures. Most of the sites would require additional personnel security clearances and enrollment of selected people in the PSAP. Estimated numbers of additional personnel needing Q-clearances are shown in Table 8. Except for Hanford FAA, the number of additional Q-cleared personnel represents a modest increment to the existing staff in existing highly secured areas. The larger number for Hanford reflects upgrading FAA security from the minimum level of PPA to PA as defined during the SET evaluation. Since then, Hanford has noted the possibility that phaseout of PFP might provide the majority of Q-cleared staff needed for the LA mission. LANL plans to satisfy the security needs of the LA project with personnel already on staff who have the required clearances.

Table 8. Other safeguards and security areas

Option	Additional personnel needing Q-clearances
SRS	10
ANL-W	10
Hanford	40
LLNL	10
LANL	0

2.3.5 Other Attributes

2.3.5.1 Site infrastructure available to support the LA project

Importance. It is important that sites being considered for the LA project have suitable, established infrastructure to support the personnel and processes planned for the project. This includes established administrative programs and physical assets such as S&S, MC&A, analytical laboratory capability, fire protection, medical services, emergency response capability and control centers, water, sewer, power, and waste management. It is impractical to create or make significant upgrades to infrastructure for a project as limited in scope and duration as the LA project.

Summary. In general, each proposed facility has suitable infrastructure needed to support the LA project. The administrative and physical upgrades to supporting infrastructure are relatively minor and are included in the reference cost estimates for each option.

2.3.5.2 Off-site transportation

Importance. It is important that the host facility accommodate all the requirements for accepting the delivery of PuO_2 by SST and shipment of completed bundles by SST. Except for the LANL option, the PuO_2 feed material would be delivered via SST to designated areas of the host site. The depleted uranium feed material would be delivered via commercial vehicles to designated receiving areas at the host site. The completed bundles containing specified arrays of MOX and low-enriched uranium (LEU) rods would be shipped offsite via SST or, possibly, via commercial trucks.

Summary. There are no significant differences among the sites with regard to the loading and unloading of SSTs. All of the sites have available capabilities to receive material delivered by SSTs. These SNM receiving areas generally are connected with SNM storage vault areas. Each site also has designated areas where SSTs can be secured during layovers. Some sites would need to make minor modifications to accommodate loading the bundles into SSTs or commercial trucks. These differences are not significant, have been included in the reference cost estimates, and should not be a factor in site selection.

LANL is the current site of the Advanced Recovery and Integrated Extraction System (ARIES) project, which is located in PF-4. Consequently, if ARIES produces the LA feed material and LANL is selected for production of the LAs, no SST shipments of PuO_2 would be required.

2.3.5.3 On-site transportation

Importance. The sites where options require on-site movement of SNM must have the processes and equipment to perform those activities in compliance with applicable DOE requirements. Approved shipping containers and suitable transport vehicles must be utilized, and appropriate security must be provided. Some on-site roads to which the public normally has access may be closed during the on-site movement of SNM.

Summary. Each of the candidate sites has approved processes, vehicles, trained personnel, and security measures in place for movement of SNM and other radioactive materials. SRS and Hanford moves would involve only the transfer of PuO_2 from the site vaults located in other buildings to the MOX fabrication line. Subsequent to the SET evaluation, Hanford determined that it would store plutonium oxide feed material in modified tube vaults in the fuel storage pit in FAA. ANL-W moves would involve short moves of PuO_2 and MOX rods between adjacent buildings. LLNL would make one movement of rods between adjacent facilities within the same security area. LANL would make one to three movements of rods and possibly two movements of bundles between the secure PF-4 and RAMROD facilities. Table 9 summarizes the different moves and forms of SNM that must be transported on-site across security boundaries for each option.

Table 9. On-site transportation

Option	On-site moves of PuO_2 from storage to processing	On-site moves of powder to pellet	On-site moves of rods to storage or NDE	On-site moves of rods to bundle assembly
SRS	Yes	No	No	No
ANL-W	Yes	No	No	No
Hanford	Yes	No	No	No
LLNL	No	No	No	No
LANL	No	No	Yes	Yes

2.3.5.4 Formal design methodology

Importance. The facility and process design must be performed efficiently, effectively, and with adequate control. Three driving reasons for this are the stringent requirements for design of plutonium processing facilities; the visibility likely to be focused on the LA project; and the desire to concurrently perform design, safety analyses, and facility modification.

Summary. Each site has formal design processes that probably are sufficient to meet the rigorous QA needs of the project and the configuration management requirements for plutonium facilities.

2.3.5.5 Waste management

Importance. Sites must have acceptable, established processes for management and disposal of wastes generated by the LA project.

Summary. DOE has devoted considerable effort during the last 10 to 15 years at all the proposed sites to establishing compliant waste management operations. All the proposed sites have the capabilities to process and certify transuranic (TRU) waste for future disposal in the Waste Isolation Pilot Plant (WIPP) and currently handle and store significant quantities of TRU waste on site. Each site has established processes for handling and disposing of both solid low-level waste (LLW) and mixed waste. The infrastructure for managing liquid radioactive wastes exists at all sites. The impact of the LA project on waste operations at each site appears to be well within the scope of existing capabilities.

2.3.5.6 Radiation protection

Importance. Equipment and processes must be designed to protect workers from unnecessary exposure to radiation. Each site has an as-low-as-reasonably-achievable (ALARA) program, which provides guidance levels for worker radiation exposures that are significantly lower than the legal limits. Designing the LA project to comply with the ALARA levels for radiation workers could significantly affect the cost of the process equipment (shielding and mechanization) and operations if the feed material contains high levels of ^{241}Am. The radiation levels in the PuO_2 and MOX fuel processes are expected to depend largely on the amount of ^{241}Am in the feed material supplied by the ARIES conversion process. LA project reference cost estimates assumed that levels of 0.2–0.4% ^{241}Am could be accommodated with a minimum amount of shielding (~0.5 in. of lead) and minor mechanization. The ^{241}Am concentration depends on the amount of ^{241}Pu (~14-year half-life) originally in the pits and will increase with the time since the last chemical separation. Depending on time since chemical separation of the plutonium, the ^{241}Am could range up to ~0.9% at the time of LA fuel fabrication. If forecasts of possible high ^{241}Am content in the LA feed material prove to be correct, the cost for additional shielding and mechanization to meet radiation worker exposure ALARA limits could increase process equipment costs by a factor of 1.5 to 2 at all sites.

Summary. Each site adheres to the DOE control limit for the maximum exposure for individual radiation workers of 2 rem/year. The maximum exposure for DOE radiation workers is the historical international standard of 5 rem/year. The candidate sites have similar ALARA average exposure goals (DOE requirement) that range from 500 to 700 mrem/year and have slightly different maximum exposure control limits for an individual worker. Each site requires documentation and approvals for exposures above the average ALARA target goals up to the site control limit. The ALARA goals for new missions are comparable and should not be a factor in site selection. However, these new ALARA goals and the ^{241}Am level in the PuO_2 feed could have a significant effect on process equipment and operating costs for the LA project. The ALARA goals for the candidate sites are presented in Table 10.

There are only slight differences in the worker exposure controls at the proposed sites, and at the level of detail available, there were no appreciable cost differences identified in the process equipment costs between sites.

Table 10. Site ALARA goals for radiation workers

Option	Site upper control limit (maximum individual) (mrem/year)	ALARA goal for current missions (group average) (mrem/year)	ALARA goal for new missions (group average) (mrem/year)
SRS	2000	750	500
ANL-W	1500	~750	~500
Hanford	2000	600	500
LLNL	2000	~750	~500
LANL	1950	~700	500

2.3.5.7 Decontamination and decommissioning

Importance. D&D of facilities for the LA project must be considered and could significantly affect the life-cycle cost of a given option for the LA project.

Summary. In general, the sites expect the project funding to return the facilities to the condition present before the project began. Thus, the D&D effort would focus on process equipment and glove boxes used in handling the PuO_2 powder. At all sites, D&D would include removal of unwanted equipment and analytical instruments from the glove boxes and cleaning the inside of these glove boxes to a minimum practical contamination level. It is unlikely that these glove boxes can be cleaned in-place to a level below that required to be classified as non-TRU waste. Most sites proposed leaving the cleaned, but still contaminated, glove boxes and some usable equipment and instruments in place in the facilities for future missions.

The level of effort required for removal of the contaminated equipment items and cleaning the glove boxes would not vary significantly among sites. With the exception of the uncontaminated FAA, all the other proposed facilities are contaminated to some extent, and either leaving the contaminated glove boxes in place or removing and disposing of these likely can be equally justified at all sites. Because FAA may be used in conjunction with another mission, the D&D for FAA likely also would be comparable to the other sites.

The reference cost estimate used basically the same cost estimates for the D&D activities for each option. The need for LA project D&D is at least 10 years in the future. During that period, DOE missions at the various sites may shift, and assumptions about D&D activities may be redefined. Because of this level of uncertainty, attempting to develop discriminating D&D costs among the sites is unrealistic. The cost for D&D for all sites was estimated as the same. The D&D costs with glove-box disposal would increase the waste disposal cost by a factor of 2 for each site from the estimated costs.

3. SAVANNAH RIVER SITE

3.1 DESCRIPTION OF SRS

SRS was established in 1951 for the production and processing of nuclear materials for national defense. The site is located in the Central Savannah River Area (CSRA), a region consisting of nine counties in South Carolina and Georgia. The CSRA has short, mild winters, moderate autumns, warm springs, warmer summers, and an annual average temperature of 64°F.

SRS is a large site with limited public access. It occupies an area of approximately 310 $miles^2$ in south central South Carolina. The Savannah River forms the site's southwestern boundary for 27 miles on the Georgia border. The center of the site is approximately 22.5 miles southeast of Augusta, Georgia, and 19.5 miles south of Aiken, South Carolina, the nearest population centers.

SRS was designed to isolate operations involving large amounts of radioactive materials, such as processes in the H-Canyon and F-Canyon complexes, near the center of the site. This arrangement created a buffer zone that enhanced security for the site and reduced the risk of accidental exposure to the general public.

3.2 FACILITIES AND PROCESSES PROPOSED FOR THE SRS OPTION

3.2.1 Facility Descriptions

The SRS proposal for fabricating MOX fuel for the LA project calls for the PuO_2 powder feed to be received and initially stored in APSF, a new facility to be located adjacent to F-Canyon and expected to be completed by September 2001. Fabrication and analytical operations to produce and qualify the MOX fuel would be housed in H-Canyon in surplus space currently occupied by USF, a cancelled project that was partially completed. This space is within the security zone that surrounds the H-Canyon complex. The MOX fuel bundles would be packaged and shipped from the dock area adjacent to the USF. Some analytical services would be performed at the SRS Central Laboratory located about 5 miles from H-Canyon.

All of the MOX fabrication and analytical processes for the LA project, except for limited support from the Central Laboratory, would be housed in the space currently occupied by the USF. The USF is located in a 6000-ft^2, three-level space on two floors in section two of H-Canyon. The USF project was halted when it was 90% complete. The USF equipment and the associated piping and wiring would be removed to permit installation of the MOX process glove boxes and equipment. Many of the glove boxes and much of the equipment in an existing first floor analytical laboratory and a small storage vault on the second floor would be used. The USF process modules were never placed in service and are presumed uncontaminated. Thus, the unwanted portions of the USF system can be removed and the space modified to house the LA project without imposing burdensome contamination controls.

Access control, locker rooms, administrative space, and waste management activities would be shared with the existing HB organization. The space designated for use by the LA project is within an operational plutonium-handling facility that has active infrastructure suitable for supporting the fabrication of MOX fuel.

A significant design and construction effort is required to transform the USF space to a facility for production of MOX fuel. USF modules and the associated interconnecting piping and wiring for electrical power and instrumentation must be dismantled and removed. The ventilation system would require redesign and modification, including some duct rerouting and the addition of glove box exhaust ventilation filters and fans. An inert gas system must be designed and installed. Existing utility service connections must be redesigned to adapt to the MOX process glove boxes and equipment. Hardened walls would be built in the area immediately south of the USF to extend the MAA and provide an area for receipt of incoming materials and partially filled uranium fuel bundles and shipment of finished fuel bundles containing both uranium and MOX rods. An existing vaultlike room on the mezzanine would be upgraded for in-process materials storage. The MOX process glove boxes and equipment must be designed to fit the unique confines of the three-level space. The configuration of the space and access to it would present challenges in design and construction, and perhaps in operations.

PuO_2 feed material would be received at the SST unloading and receiving facility in the new APSF in F-Area. The PuO_2 would be stored at APSF until it is needed and transferred to H-Canyon for MOX processing.

A small vault on the second floor of the H-Canyon MOX processing facility would be used for storage of batch feed material and interim storage of in-process materials.

Most of the analytical processes for the LA project would be performed in the first floor laboratory of the H-Canyon MOX fabrication facility. This arrangement would provide for committed real-time analyses to support MOX process control and product certification. The SRS Central Laboratory would be used for testing that exceeds the capabilities of the MOX laboratory. The Central Laboratory is an operating laboratory that routinely provides process control, accountability, nuclear safety, and product specification support for various SRS operations.

3.2.2 Process Descriptions

3.2.2.1 Powder receipt and storage

The PuO_2 would be received and stored initially in the new APSF. An existing but unused vault is present on the mezzanine level of the USF area. This vault would be upgraded with a vault door, closure of some existing wall penetrations, and installation of alarm systems.

An S&S Category I quantity of material (PuO_2) would be delivered by SST vehicles and received at the APSF in F-Area. The necessary receipt and accountability procedures would be performed, and the material would be placed in temporary storage. When additional powder is needed, it would be transported intrasite to the H-Canyon MOX fabrication facility.

DUO_2 would be received via commercial carrier. The site has suitable facilities to receive and store the DUO_2 until it is needed in the MOX fabrication process.

A small vault located on the mezzanine level in the MOX fabrication area would be used to store containers of PuO_2 feed materials. This vault also would be used for storage of in-process batches of master blend powder, green pellets, and sintered pellets.

3.2.2.2 Powder, pellet, and rod fabrication

Feed material from the mezzanine vault would be moved to the second-level room where the receipt glove box is located. This room would provide an additional level of containment for the initial powder preparation operation where PuO_2 material would be in higher quantity and concentration than elsewhere in the MOX fuel fabrication process.

The PuO_2 can and DUO_2 pail would be introduced into the feed material entrance glove box, where lids would be opened, necessary assay functions would be performed, and the materials would be selected to create a batch of 30% PuO_2 master blend. The batch of material would then be placed in the blender. A small amount of recycled hard scrap MOX powder may be added to the batch to obtain the desired blend.

After the first blend process, the powder would be sampled and processed through a milling operation in the same glove box. Milled powder would be transferred to an adjacent glove box to be compacted, granulated, and screened. Then the material would be placed in a blender for final blending. Binder may be added during the final blending. Next, the prepared MOX powder would be stored in the mezzanine vault or forwarded to the pellet line.

The MOX powder from the final blend process or from the mezzanine level vault would enter the pellet fabrication glove box on the second floor and be placed into the pellet press feed hopper. Green pellets removed from the press would be stacked onto trays and then into boats. The boats would be covered and either stored or loaded into the sintering furnace. Sintering is expected to reduce the size of the pellets by about 20%. After sintering, pellets would be inspected for size, oxygen content, and density before being placed in storage or transferred to the grinding and inspection glove box. Grinding would be used to achieve specified pellet dimensions. After grinding, pellets would be inspected for size and for surface defects. Pellets meeting all specifications would be stored in racks for subsequent rod loading. Reject pellets would be stored in separate containers pending recycle or scrapping. The racks of certified pellets would be stored in the mezzanine level vault if they were not used immediately for the fuel rod loading operation.

Rod filling, tube-end decontamination, pressurization, and seal welding of end caps would be performed in a workstation with a multistage glove box at one end. This workstation would be located in the first-level room below the in-process vault. Racks of certified pellets would be transferred to the rod filling station from the pellet line or via an existing dumbwaiter from the vault.

SRS assumes that fuel pins would be received with one end cap already welded. The tube would be introduced to the first compartment of the glove box where pellets would be loaded and the open tube end decontaminated. Next, the tube would proceed to a second and third compartment where the subsequent welding and pressurization operations would be carried out to complete the rod assembly.

The fuel rods would be decontaminated, if required, and transferred to a helium leak test chamber and NDE station for X-ray inspection of the seal welds. Then the rods would undergo gamma scanning and additional inspection and tests before being placed in trays for storage or transfer to the bundle assembly station.

3.2.2.3 Interim storage of powder and pellets

The mezzanine vault would be used for interim storage of feed material, blended powders, green and sintered pellets, and reject and scrap material.

3.2.2.4 Interim storage of rods

Fuel rods placed in sealed trays with supports would be stored on racks in the rod fabrication room or the bundle assembly area until they are needed for bundle assembly.

3.2.2.5 Bundle assembly and inspection

Bundle assembly would be performed on the north end of the first-level high-bay area that would be open to the ceiling of the second floor. An assembly station with a tilt table would be used for the insertion of fuel rods into the bundle assembly. Bundles would be received from the consortium preassembled with the uranium oxide rods installed, such that only the MOX rods would be inserted. Because the number of LA bundles is small, it is envisioned that loading would be done manually, one rod at a time.

3.2.2.6 Bundle storage

A rack would be installed on the west wall of the first level to provide vertical bundle storage. Up to six positions would be provided for storage of bundles until they are packaged and shipped to the off-site commercial reactor. A tilt table would place the bundle in a horizontal position for rod insertion and then in a vertical position for inspection and transfer to the storage rack by an overhead hoist. A strongback transfer device would support the bundle assembly as it is transferred to the second-level packaging and shipping area. This move would require carefully guiding the bundle through a 3-ft clear space over an existing stairwell. Fuel bundles would be packaged for shipment in the second-level space located immediately south of the former USF area. This area is accessible by truck or SST for final shipment.

3.2.2.7 Handling of consortium-supplied hardware

The site would receive and store consortium-supplied hardware until needed in the fabrication process. The consortium is expected to supply (1) sufficient rod hardware to produce rods loaded with 3 MT of MOX fuel (approximately 1500 rods plus spares) and (2) fuel bundles partially filled with LEU rods. Also, the consortium may choose to supply process equipment or tooling.

3.3 CHARACTERIZATION OF THE SRS H-CANYON OPTION

3.3.1 Project-Level Attributes

3.3.1.1 Facility and mission compatibility

The area in H-Canyon, Building 221-H, committed by SRS for fabrication of MOX fuel for the LA project is designated by SRS as surplus space that has no mission assignments. The activities required to successfully implement the proposed LA project and other identified proposed and ongoing missions in surrounding SRS facilities are compatible. The H-Canyon area proposed for the MOX processes currently contains process equipment from a project that was cancelled when construction was 90% completed. The LA project activities and the existing site infrastructure are mutually compatible.

3.3.1.2 Cost and cost risk

The reference cost estimate for the SRS H-Canyon option for the LA project is $76M in constant FY 1998 dollars. The reference case contains data that incorporate comments by the site. After reviewing data from all the options, SET identified indeterminate factors that could cause the estimate to increase or decrease and used these factors with the reference case values to establish a cost range for the SRS option. Figure 6 shows the ranges of estimated cost by project phase for the SRS option. The adjustment factors are discussed below and summarized in Table 11. All costs are given in millions of unescalated FY 1998 dollars.

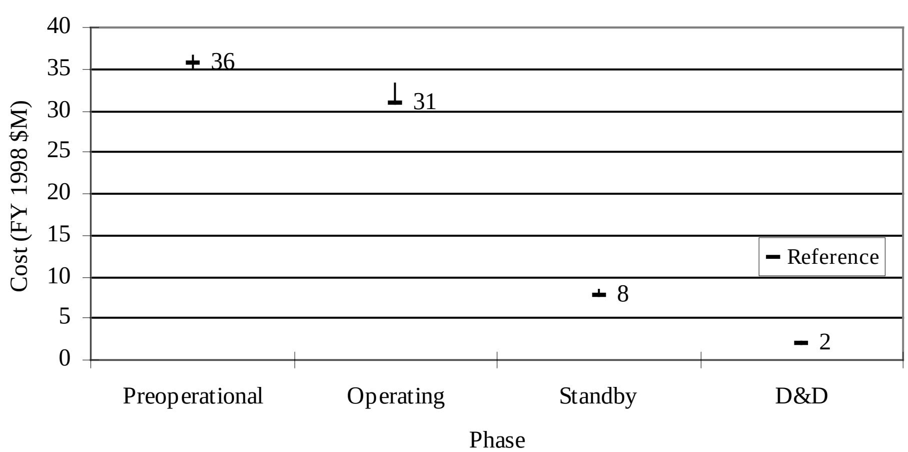

Fig. 6. Cost ranges by phase for the SRS option.

Table 11. Cost adjustments for the SRS option by project phase

Factor	Cost adjustment ($M)				
	Project total	Preoperational phase	Operational phase	Standby phase	D&D phase
Space charges	0.0	0.0	0.0	0.0	0.0
Labor rates	+4.5	+1.1	+2.5	+0.8	+0.1
Schedule reduction	-0.3	-0.3	0.0	0.0	0.0
H-Canyon SAR	0.0	0.0	0.0	0.0	0.0

After studying the data provided by each site for burdened labor rates and other cost factors such as user fees, space charges, and program loads, SET adjusted the labor rates and various fees used in the project models for each option to provide the most direct cost comparison possible among the options. By applying this process, SET computed an adjustment for the SRS option that increased the estimated costs associated with labor rates by $4.5M. No adjustment was made in the costs associated with space charges.

A factor that could lower project cost would be the shortening of the preoperational phase of the project. SET estimated that the SRS option could be shortened by as much as 4 months without incurring cost or quality penalties. Further, SET estimated savings of approximately $0.3M for the potential schedule improvement.

A factor that could increase the cost for the SRS option is the plan to amend the H-Canyon BIO to include the LA project instead of producing a DOE 5480.23-format SAR for the activity. If hosting the LA operation forces the development of a DOE 5480.23-format SAR for the entire 221-H-Canyon facility, an additional cost in millions of dollars would be expected. SRS indicated that the likelihood of having to produce a SAR for H-Canyon as a result of the LA project is extremely small. Consequently, no adjustment was made to the reference case estimate for this factor.

Some increases in design and construction costs also might result if designing the process to fit within the constraints of the proposed space proves more difficult than assumed in the reference cost estimate. On the other hand, the compact, three-level layout in the SRS option may become an asset if the consortium wishes to install equipment to facilitate vertical process flow. No adjustment to the reference case was made for these considerations.

3.3.1.3 Schedule and schedule risk

The schedule developed by SET in collaboration with the SRS team shows that this option can meet the June 2003 milestone for the fabrication of the first qualified MOX rod.

Some announcements about beginning the decommissioning of the H-Canyon complex, if implemented, would adversely affect the proposed LA project. However, the decommissioning discussions are at odds with other announcements, such as the plans for plutonium and neptunium powder production in the HB-Line, Phase II facility. Evaluation of these issues is beyond the scope of this review.

It is possible that the schedule for the SRS option could be improved, but to do so would require significant effort. The proposed space is filled with process modules and equipment from the cancelled USF project. The USF items must be disassembled and removed; utility service connections must be redesigned and reconstructed; the MOX process glove boxes and equipment must be designed to fit into a confined, three-level space; and new glove boxes, equipment, and services must be constructed in confined work space and with restricted openings for access to the area. In addition, the work would be performed under tight security requirements. SET agrees that the work can be done in time to meet the June 2003 milestone; however, the possibility for significant schedule improvement without escalation of cost appears slight. SET estimated a possible improvement of only 4 months and a related reduction in cost of $0.3M.

3.3.1.4 Quality assurance program

SRS has no recent, direct experience in producing reactor hardware under the control of NRC QA requirements contained in 10 CFR 50, Appendix B; however, with planned support from the consortium, SRS should be able to meet the requirements. SRS staff might be able to call upon their parent companies for commercial nuclear QA expertise. This attribute is important because the assemblies fabricated for irradiation testing during the LA project must meet consortium and NRC QA requirements.

3.3.2 Operational Attributes

3.3.2.1 Production-processing approach

The spaces proposed for this option have no significant physical or operational characteristics that would prevent the design and implementation of an efficient, productionlike process. The cramped space and constrained access may require more design and construction effort than some of the other options, but no fundamental reasons exist that prohibit placing an efficient pilot-scale process into operation in the proposed space. The process is expected to be able to meet requirements for equipment, batch size, and QA. The SRS team indicated that their process could be based either on campaigning batches or steady-state processing in accord with the desire of the consortium.

3.3.2.2 MOX fuel fabrication experience

Some SRS personnel have previous MOX experience, but the site staff has no direct MOX fuel fabrication experience. Personnel at SRS have extensive experience in large-scale chemical processing of plutonium and enriched uranium in powder and liquid form and in both remote and contact handling of materials in glove boxes. This experience is relevant to the proposed LA project. SRS has over 30 years experience in fabricating reactor fuel for the defense program.

3.3.2.3 Existing prototypic process equipment

The proposed area has no prototypic MOX processing, bundle assembly, or analytical equipment. Prototypic analytical equipment exists, but additional equipment [e.g., sieves and subsieves, oxygen-to-metal (O:M) ratio, and ceramography] for process control and product certification would be installed in the H-Canyon MOX fabrication area.

3.3.2.4 Batch size flexibility and analytical optimization

Plans for this option call for MOX batches up to 150 kg in size. This size is suitable for ensuring uniformity of MOX pellets and reasonable analytical costs. Smaller MOX batches can be processed to produce small numbers of pellets of various enrichments.

3.3.2.5 Characterization of proposed facilities for processing

The space proposed is a three-level area adjacent to the process hot cells within the operating H-Canyon facility. The proposed space is currently an S&S Category II area that contains an unused uranium processing line that must be dismantled and removed. The MOX process equipment would be installed on the three levels within the proposed space. This multilevel option may offer some advantages in gravity material transfers; however, handling of rods and fuel bundles may be awkward because of confined space within the area and constrained access to the area. Upgrading of the HVAC system would be required.

3.3.3 Safety-Related Attributes

3.3.3.1 NEPA compliance

MD is preparing a site-specific EIS that is intended to be sufficient for conducting the LA project at any of the candidate sites without further NEPA actions. There is some risk that unspecified process or facility changes might require additional action. It is anticipated that any site selected would need to prepare supporting documentation to ensure that the EIS includes bounding case scenarios for the site-specific process and design. Additional NEPA action, if required, could delay the LA project.

3.3.3.2 Safety bases

The 221-H-Canyon facility is currently a Hazard Category 2 nuclear facility operating under a BIO. SRS proposes to amend the existing BIO and currently has no plans to update its safety basis documentation to a DOE 5480.23-format SAR during the next 10 years. If a DOE 5480.23-format SAR were deemed a requirement for the proposed H-Canyon MOX fabrication process, and, as a result, a DOE 5480.23-format SAR had to be produced for the entire H-Canyon facility, the resulting SAR might cost several million dollars. SRS believes that a requirement for a DOE 5480.23-format SAR for H-Canyon is improbable. If a DOE 5480.23-format SAR were required, SRS anticipates that the SAR could be completed and approved within the current 4-year startup schedule of the LA project. The cost for an H-Canyon SAR is not included in the SRS reference case estimate.

3.3.3.3 Operational readiness review

The SRS team plans to conduct a full DOE ORR before introducing either uranium or plutonium into the proposed H-Canyon MOX process line. A DOE ORR, performed in accordance with DOE Order 425.1, would involve self-assessment, contractor-independent assessment, and support to the DOE ORR team. Experienced SRS staff is available to support this requirement.

3.3.3.4 DOE Order compliance

The proposed LA project will be regulated by DOE but led by the consortium. The consortium may be unfamiliar with DOE regulations and would expect the host site to ensure smooth, compliant operation. Furthermore, the project likely would be closely scrutinized by NRC and the regulatory offices of the consortium utility. The site would be responsible for ensuring regulatory compliance.

The SRS team demonstrated support for rigorous compliance with applicable requirements.

3.3.3.5 Compliance with plutonium-processing and -handling facility design criteria

H-Canyon is an operating plutonium facility. The facility has been upgraded and well maintained. The staff and management demonstrate understanding of and compliance with PPHF criteria.

3.3.4 Safeguards and Security-Related Attributes

3.3.4.1 Physical protection

The primary area where physical protection upgrades would be needed is the space surrounding and including the current USF located in H-Canyon. The H-Canyon building is a hardened concrete structure located within a PA. The USF area is currently an S&S Category II facility and would require upgrading to become a Category I facility. No PIDAS surrounds the H-Canyon building. Few physical security systems exist within the USF area. Thus, it would be necessary to design and install needed physical protection systems and components, such as sensors, balance magnetic switches (BMSs), cameras, barriers, hardened doors, and personnel and material access controls. Once the components and systems are installed, testing would need to be done. This would involve all security systems associated with the MOX fabrication areas. Also, increased numbers of protective force personnel would be needed to protect the Category I quantities of SNM. Nine additional security personnel would be added to support the MOX fabrication and material movement activities.

The protective systems at APSF are presumed to be adequate for the LA project. APSF systems would be reviewed as part of the security preoperational evaluations.

3.3.4.2 Material control and accountability

No MC&A capabilities currently exist at the proposed MOX fuel fabrication location that is within a Category II MBA. A separate Category I MBA probably would be established for the LA project. The material accountability (MA) for the initial receipt of the PuO_2 would be done at the APSF. A preliminary MC&A and nuclear measurement assessment of the material flow has not been done. Operations and analytical laboratory personnel would perform some of the MC&A functions (e.g., nuclear measurements, SNM accountability, MBA custody, and process vault operations). One additional person would be added to support these functions.

The analytical laboratory that is to be in the H-Canyon MOX fabrication area would provide most of the NDA and DA support. Also, some analytical resources of the nearby HB-Line may be used to support the MOX fabrication process. NDA for rods is probably the only nuclear measurement that is not available somewhere at SRS; however, no DA or NDA capability currently exists in the area proposed for MOX fabrication. Thus, NDA measurement devices (calorimeter, gamma and neutron counters, and a rod scanner) would need to be installed in the MOX fabrication area.

3.3.4.3 Vulnerability assessment and site safeguards and security plans

A preliminary VA for the MOX processing areas has not been performed. Because the site is currently protecting targets that are more attractive against the same likely threats, it is not envisioned that the MOX fabrication operations would significantly impact the facility VAs. The risk of SNM transport will be assessed. No change in the site-specific threat is anticipated. A preliminary review was performed on S&S requirements. Plans need to be developed to identify S&S systems and components, procure S&S components, and install and test S&S equipment. Changes to the SSSP would be needed. Specific revisions to the H-Canyon security plan and an MC&A plan would be needed.

3.3.4.4 Radiological sabotage potential

It is not clear if the RADSAB assessment limits are beyond the criticality limit in this option. It is assumed that criticality limits may be up to 10 kg of PuO_2, resulting in allowable MOX batch sizes up to 200 kg. This may be a conservative limit because the process planning is for 150-kg batches of MOX.

3.3.4.5 Access by foreign nationals and uncleared personnel

The proposed MOX processing area within the H-Canyon Building is to be located within a PA and an MAA. All uncleared personnel would need to be escorted throughout the duration of this project. Areas for the MOX fabrication prior to actual operations would be within a PA, and after PuO_2 is present, the MOX processing area would become an MAA. The MOX processing area is not expected to contain any classified or otherwise sensitive items or material that must be shielded from the vision of visitors. However, H-Canyon and the HB-Line may contain information and material that would require protection from visual access by foreign nationals. When the area becomes an S&S Category I area, access by foreign nationals would be more inconvenient but still possible.

3.3.4.6 Special nuclear material storage

The PuO_2 would be received and stored initially in APSF, which is to be built before the start of the MOX fuel fabrication operations. All receipt, handling, and material accountability would exist at APSF; no additional capabilities would be necessary. From this facility the PuO_2 would be moved as needed to the mezzanine-level processing vault located in the MOX fabrication area in H-Canyon. The APSF and the MOX fabrication areas are located in two different areas of SRS.

The MOX powders and pellets would be stored in the MOX processing area glove boxes or in the mezzanine-level storage vault in approved containers. A fairly intensive effort would be required to design and make modifications for the vault. The space designated for the vault now contains USF equipment that must be disassembled and removed. An assessment of the designated vault space must be done and a determination made of the needed upgrades. A vault door would be required, openings through the walls would need to be closed, and S&S equipment such as BMS, an intrusion detection system (IDS), and video would need to be installed.

Some rods would be stored in the processing area until they can be moved to an area for storage and assembly into bundles. The area for rod and bundle storage also is filled with USF equipment that would need to be disassembled and removed. Rods would be stored in sealed trays on racks until they are needed for bundle assembly. Bundles would be stored on wall-mounted racks. An existing monorail system would be used to move rods and bundles within the area and to the shipping area. The monorail would require modification.

3.3.4.7 Other safeguards and security characteristics

Other S&S programs are in place, and some personnel have the required security clearances for accessing Category I quantities of SNM. Several other staff members would need upgrades to their security clearances. The added security personnel also would need security clearance upgrades (if they do not have them) and enrollment in the PSAP. Ten new clearances or upgrades would be needed.

3.3.5 Other Attributes

3.3.5.1 Site infrastructure available to support the LA project

Suitable site infrastructure for the LA project either is available to the proposed operating area or can be provided with minor administrative or equipment upgrades. These infrastructure items include S&S; MC&A; analytical laboratory capability; fire protection; medical aid stations; emergency response capability and control centers; water, sewer, and utilities; and waste management.

3.3.5.2 Off-site transportation

The PuO_2 would be delivered by DOE SST vehicles and would be received at the APSF located near F-Canyon. The APSF, scheduled for completion in September 2001, would perform receipt measurements and store the powder until needed by the MOX fabrication process. No modifications are anticipated at APSF to accommodate the LA project. Containers of PuO_2 would be moved intrasite to the MOX fabrication area in H-Canyon as needed.

DUO_2 would be shipped via commercial carrier, received at N-Area, and then moved to H-Canyon.

Partially filled fuel bundles containing rods of LEU would be received at the H-Canyon loading dock on the south side of the MOX fuel fabrication area. Shipping packages containing the incoming bundles would be unloaded from trucks at the dock and moved into the second floor storage area immediately outside the MOX fabrication area.

Packages containing bundles with various loadings of MOX fuel would be shipped to the reactor site via commercial truck or SST from the same second-floor dock used for receipt of the partially filled LEU bundles. It is assumed that DOE would provide certified shipping containers, probably the Mixed Oxide-1 (MO-1) package, for bundles containing MOX fuel rods. The dock has no concealing cover to accommodate S&S shipments, but this should not be a major problem. Some minor upgrades may be needed for the H-Canyon loading area if SSTs are used to ship the bundles containing MOX.

SSTs can be left unattended overnight inside the tritium facility PA or at the APSF.

3.3.5.3 On-site transportation

Except for waste and laboratory samples, the only on-site transport of SNM necessary to support the LA project is the movement of the PuO_2 from the APSF to the MOX fabrication area in H-Canyon. This movement would be made over roads controlled by SRS using established procedures. SRS interior roads are controlled by security barricades at the entrances on major roads and by locked gates on the secondary roads. Three roads on SRS property are available for public use (SRS RD1, SC125, and US278). The site has extensive experience in moving special SNM, including laboratory samples and SNM waste, within the site boundaries. Transport, escorts, and procedures are already in place for such moves. Minimum upgrades would be required for on-site transportation.

Upon receipt at the MOX fabrication shipping and receiving area, PuO_2 containers would be moved via an existing dumbwaiter or stairs to the mezzanine-level vault. Containers may be needed for both the on-site transport and intrabuilding movements. The powder likely would be kept in its shipping container until needed in the process line. Other containers would be needed for storage and movement of the various blends of MOX powder and pellets within the MOX processing area.

3.3.5.4 Formal design methodology

The SRS organization has an established facility engineering function that is well-versed in DOE design criteria.

3.3.5.5 Waste management

Existing SRS capability to manage and dispose of waste is expected to be adequate for the needs of the LA project. The site has the capability to process and certify TRU waste for future disposal in WIPP and currently handles and stores significant quantities of TRU waste on site. Solid LLW and mixed waste also are handled routinely and either stored for disposal off site or disposed of on site. The infrastructure exists for the handling and processing of liquid radioactive wastes. The impact of the LA project on waste operations at SRS appears to be well within the scope of existing capabilities.

3.3.5.6 Radiation protection

All sites have comparable ALARA goals for radiation workers. The ALARA goal at SRS for a new mission is a group average of 500 mrem/year compared to the current goal of 750 mrem/year.

3.3.5.7 Decontamination and decommissioning

SRS expects to remove and dispose of some contaminated equipment items, decontaminate the glove boxes, and leave the glove boxes and other equipment and instruments in place at the close of the project. No other D&D actions are planned under the LA project. SRS has experience in decontamination of glove boxes.

4. ARGONNE NATIONAL LABORATORY-WEST

4.1 DESCRIPTION OF THE ANL-W SITE

The ANL-W option for siting the LA project was presented jointly by ANL-W and INEEL. The option proposes the use of FMF and other facilities located on the ANL-W portion of the INEEL site.

INEEL, 890 miles^2 of high desert land, is 39 miles long from north to south and 36 miles wide at its broadest point. ANL-W, part of the Argonne National Laboratory (ANL), is located about 35 miles west of Idaho Falls, Idaho, on the southeastern portion of the INEEL site.

ANL, a nonprofit research laboratory operated by the University of Chicago for DOE, applies its R&D skills on a broad range of national problems. Research at ANL-W focuses on energy technologies, nuclear safety, spent nuclear fuel, nonproliferation, D&D technologies, and similar work. Typically, basic research is conducted at the main laboratory near Chicago, with large-scale nuclear facility testing and development done at the Idaho site.

4.2 FACILITIES AND PROCESSES PROPOSED FOR THE ANL-W OPTION

4.2.1 Facility Descriptions

The ANL-W proposal for fabricating MOX fuel for the LA project calls for the use of portions of FMF; the ZPPR reactor cell, workroom, and vault; and FASB. FMF (Building 704) is a Hazard Category 2 nuclear facility, built to standards in 1986, designed for uranium fuel fabrication and plutonium fuel storage and handling to support EBR-II. The ZPPR facility was built to allow the mock-up of full-sized breeder reactor cores using critical assemblies with full plutonium loadings. The FASB currently is classified as a radiological facility and was previously used for fabrication and storage of EBR-II fuel element jackets. FMF and ZPPR are S&S Category I buildings, and the FASB is an S&S Category III building.

FMF is a hardened facility located next to the ZPPR facility. The building includes a vault, which would be used for much of the bulk processing activities, and other adjacent rooms, which would be used for other related MOX fabrication activities. The FMF is currently used for uranium processing and handling operations, nuclear material storage, and materials characterization. The vault area has an 18-in.-thick concrete floor slab, 14-in.-thick exterior walls, and a 9-in.-thick roof slab. The roof and walls are covered with 4 ft of soil. The other rooms of FMF consist of a 12-in. concrete floor slab, 12-in. masonry block walls, and 9-in. hollow core slabs with a 2-in. topping on the second floor and roof. FMF is an MAA located within a PA. In addition to the security features of the MAA and PA, entrance is through double barrier (airlock) doors.

The ZPPR reactor cell is a 50-ft-diam, 23.5-ft-high circular room with the floors and walls constructed of reinforced concrete. The ZPPR cell utilizes a refined “Gravel Gertie” architecture. The ZPPR vault and workroom consist of a 14-in. concrete floor slab, 12-in.-thick concrete walls, and a 7-in. concrete roof slab over precast T-beams. The roof and walls are covered with a minimum of 4 ft of soil. The ZPPR reactor is currently in nonoperational standby status. The ZPPR vault and workroom remain operational to support nuclear materials storage in the ZPPR vault. The ZPPR is an MAA located within the same PA as FMF. In addition to the security features of the MAA and PA, entrance to the ZPPR reactor cell is through double barrier (airlock) doors.

The FASB is a reinforced concrete masonry high-bay building with a roof of precast concrete double-T sections that are connected by weld plates. The building has two major areas, the east room and the west room, and a vault that is accessed from the west room. The FASB originally was used to house EBR-II fuel element fabrication, subassembly fabrication, and fuel storage. Currently, the FASB is operated as a laboratory. The FASB is used for controlled inventory of consumable supplies and small quantities of depleted uranium and LEU.

The analytical laboratory provides chemical, radiochemical, and physical measurements in support of ANL-W nuclear and environmental programs. The laboratory is located in an administrative building within the ANL-W PPA.

Minimal modifications would be required in the ANL-W facilities to accommodate the LA project. The majority of the modifications would occur in FMF. In FMF, some fire suppression sprinklers would be eliminated, the north room and vault would be painted with an Amercoat decontaminatable coating, and the new glove boxes would be incorporated into the existing facility fire protection system. The most extensive modifications would be the consolidation and transfer of existing FMF SNM inventory and the preparation of the existing vault space for the proposed process activities. The monitoring and alarm system would be upgraded, and additional battery backup power supplies would be installed. An FMF upgrade to allow operation as a plutonium laboratory is currently in the Title II design phase. These modifications are planned for completion in FY 1998. Additional upgrades to meet the LA project requirements include the addition of a third zone of confinement. The LA project glove boxes would be integrated into the FMF ventilation system, and high-efficiency particulate air (HEPA) filters would be installed inside each glove box.

The FASB would require installation of bundle assembly equipment that would comprise fixtures for bundle assembly, inspection, and then reorientation for horizontal transfer and storage. No major building modifications are anticipated for FASB, although the proposed overhead hoist is rated at only 500 lb and may need to be upgraded or replaced.

No major modifications would be required for ZPPR. The workroom is adequate, but the vault may require some reconfiguration to accommodate the incoming PuO_2 and SNM from the FMF vault. The ZPPR reactor cell may require some reconfiguration of its contents to accommodate bundle storage racks. No upgrades should be needed for the ANL-W support activities.

4.2.2 Process Descriptions

4.2.2.1 Powder receipt and storage

The ZPPR workroom and vault would be the location for the receipt and inspection of the PuO_2 and DUO_2. If early analysis of feed materials is desired, then the containers could be transferred to FMF for sampling. The PuO_2 would be stored in the ZPPR vault, and the DUO_2 would be stored in the ZPPR Mock-up Building. It was assumed that the PuO_2 feed would arrive in three shipments distributed over the duration of the mission. Any NDA measurements for receipt activities would be located in the ZPPR workroom.

4.2.2.2 Powder, pellet, and rod fabrication

As needed for the processing operations, PuO_2 and DUO_2 would be moved to the FMF for blending operations. Nearly all process functions are proposed to be located in FMF. To form the master blend, 5 kg of PuO_2 and 11.7 kg of DUO_2 would be blended in a high-intensity blender housed in a glove box. The final blend would be made by mixing the 16.7-kg master blend with 83.3 kg of DUO_2 in a low-intensity blender. The prepressing operations and pellet production activities would be in adjacent glove boxes. Sintering would be performed in a continuous-feed furnace. A glove box containing a grinder would be attached to the sintering glove box. Some amount of automation or mechanization is envisioned for handling-intensive tasks. Glove boxes would be arranged in a serial fashion and connected through transfer ports. The glove boxes would all contain a pass-through, dried-air atmosphere except for the welding glove box, which would be filled with helium.

The rod-loading operations would also take place in FMF. The rod inspection and NDA procedures would be carried out in the north room of FMF. The exact configuration for the rod inspections needs further refinement and may involve both horizontal and vertical orientations. If vertical orientations are necessary, then the FMF pit must be used to provide the necessary height, and such operations would be more cumbersome.

Supporting analytical processes would be performed in FMF and in the ANL-W analytical laboratories. Dimensional and mass measurements would be located within the process line. The FMF south room would be equipped with the majority of the analytical instruments needed to support the project. The close proximity of the dedicated analytical support laboratory to the process would facilitate prompt and cost-effective feedback for process control and product certification. The analytical laboratory resources would be used for wet chemistry and for specialized chromatographic and spectrographic tests.

4.2.2.3 Interim storage of powder and pellets

The pellets would be placed in temporary containers for interim storage in either the vault or a storage glove box located in the ZPPR reactor cell.

4.2.2.4 Interim storage of rods

Rods would be stored in either the FASB vault or the ZPPR reactor cell. Storage racks would be used to store the rods and bundles.

4.2.2.5 Bundle assembly and inspection

The FASB is proposed to be used for rod storage and bundle assembly, inspection, and packaging for shipment. Bundle assembly is proposed for the FASB east room. The bundle assembly would be performed with the bundles in a horizontal configuration. The FASB is a high-bay building, so adequate height exists for the bundle inspection. The bundle inspection would be performed with the bundle hanging vertically from an overhead hoist, extending somewhat into the east room trench.

4.2.2.6 Bundle storage

Because the FASB vault likely cannot be approved for Category II quantity storage of fuel rods or bundles, no more than one fuel bundle would be stored in the FASB at a given time. Storage of multiple fuel bundles would be in the ZPPR reactor cell. Under this scenario, the FASB vault could be used for storage of a single bundle, allowing ample time for inspection and preliminary packaging.

Preliminary packaging of the bundles for shipment to a reactor site would be in the FASB. Bundles would be stored in the ZPPR reactor cell for longer term storage. The final packaging would be performed in the ZPPR workroom. Any process recycle materials would be stored in the ZPPR vault until recycle operations commence. The ANL-W chemistry and materials characterization laboratories would provide analytical support.

4.2.2.7 Handling of consortium-supplied hardware

The site would receive and store consortium-supplied hardware until needed in the fabrication process. The consortium is expected to supply (1) sufficient rod hardware to produce rods loaded with 3 MT of MOX fuel (approximately 1500 rods plus spares) and (2) fuel bundles partially filled with LEU rods. Also, the consortium may choose to supply process equipment and tooling.

4.3 CHARACTERIZATION OF THE ANL-W FMF OPTION

4.3.1 Project-Level Attributes

4.3.1.1 Facility and mission compatibility

FMF (Building 704), selected for processing powders and fabricating pellets and rods, has no identified mission that would conflict with the LA project. This facility previously was used for metal casting of fuel for EBR-II, which has been shut down. Likewise, the adjacent building committed by site management for bundle assembly has no identified conflicts with the LA project. The activities required to successfully implement the proposed LA project and other identified proposed and ongoing missions in surrounding ANL-W facilities are compatible.

4.3.1.2 Cost and cost risk

The reference cost estimate for the ANL-W FMF option for the LA project is $73M in constant FY 1998 dollars. The reference case contains data that incorporate comments by the site. After reviewing data from all the options, SET identified indeterminate factors that could cause the estimate to increase or decrease and used these factors with the reference case values to establish a cost range for the ANL-W option. Figure 7 shows the ranges of estimated cost by project phase for the ANL-W option. The adjustment factors are discussed below and summarized in Table 12. All costs are given in millions of unescalated FY 1998 dollars.

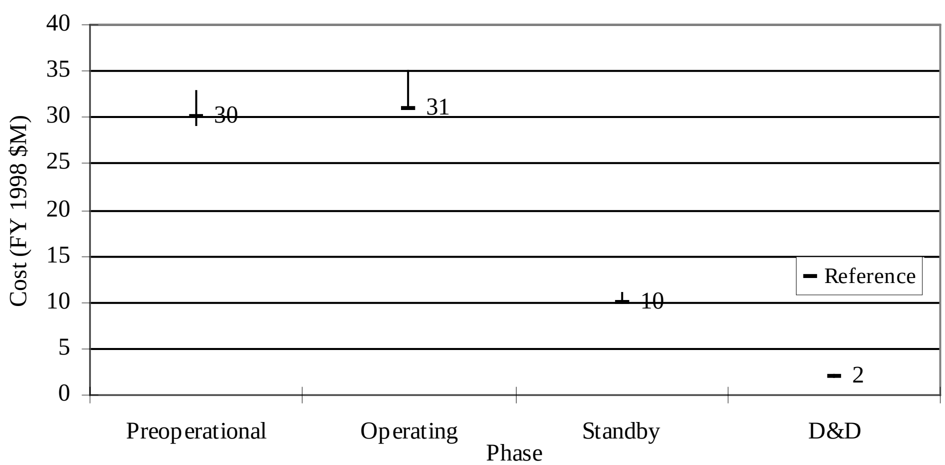

Fig. 7. Cost ranges by phase for the ANL-W option.

After studying the data provided by each site for burdened labor rates and other cost factors such as user fees, space charges, and program loads, SET adjusted the labor rates and various fees used in the project models for each option to provide the most direct cost comparison among the options possible. By applying this process, SET computed an adjustment for the ANL-W option that increased the estimated cost associated with labor rates by $8.4M. No adjustment was made in the estimated costs associated with space charges.

A factor that could lower project cost would be the shortening of the preproduction phase of the project. SET estimated that the ANL-W option could be shortened by as much as 6 months without incurring cost or quality penalties. Further, SET estimated savings of approximately $0.8M for the potential schedule improvement.

Table 12. Cost adjustments for the ANL-W option by project phase

Factor	Cost adjustments ($M)				
	Project total	Preoperational phase	Operational phase	Standby phase	D&D phase
Space charges	0.0	0.0	0.0	0.0	0.0
Labor rates	+8.4	+2.7	+4.3	+1.1	+0.3
Schedule reduction	-0.8	-0.3	0.0	0.0	0.0

4.3.1.3 Schedule and schedule risk

The schedule developed by SET in collaboration with the ANL-W team shows that this option can meet the June 2003 milestone for the fabrication of the first qualified MOX rod.

The ANL-W option has the potential for beginning the production of qualified MOX fuel earlier than the June 2003 milestone. In an action independent of the LA project, ANL-W plans to upgrade the FMF in FY 1998 to plutonium processing standards and produce a compatible SAR. This action would enhance the suitability of space proposed for the LA project. The proposed FMF space is adequate in size and has few features that would constrain establishing an efficient flow-through arrangement of the process steps. As in other operational S&S Category I facilities, the modifications would have to be performed under tight security. Time and effort could be saved by fabricating process modules, installing selected equipment items, and performing operational checks on integrated process modules in a clean off-site fabrication facility. Thus, the portion of the work that must be done under rigid Category I security can be minimized. Modifications to facilities other than FMF are minimal. Existing operating analytical laboratories located nearby have suitable capabilities to supplement the analytical equipment to be installed in FMF. No schedule risk from interference with other missions has been identified. SET estimated a schedule improvement of 6 months and related cost reduction of $0.8M.

4.3.1.4 Quality assurance program

ANL-W has no recent, direct experience in fabricating reactor hardware to the NRC QA requirements contained in 10 CFR 50, Appendix B; however, with planned support from the consortium, ANL-W should be able to meet the requirements. This attribute is important because the assemblies fabricated for irradiation testing during the LA project must meet consortium and NRC QA requirements.

4.3.2 Operational Attributes

4.3.2.1 Production-processing approach

The spaces proposed for this option have no significant physical or operational characteristics that would prevent the design and implementation of an efficient, pilot-scale process. The process is expected to meet requirements for equipment, overall batch size, and QA. The ANL-W team indicated that their process could be based either on campaigning batches or steady-state processing in accordance with the desire of the consortium.

4.3.2.2 MOX fuel fabrication experience

The site has no direct MOX experience but has decades of experience fabricating reactor fuel for irradiation in EBR-II. Most of this experience is with metal fuel, especially enriched uranium. Although this experience did not require interface with NRC or the utility reactor owners, it should be regarded as an asset to the LA project.

4.3.2.3 Existing prototypic process equipment

The site has no prototypic MOX processing or bundle assembly equipment. Prototypic analytical equipment exists, but additional equipment (e.g., sieves and subsieves, O:M, and alpha autoradiography) for process control and product certification would be installed in the FMF.

4.3.2.4 Batch size flexibility and analytical optimization

Plans for this option call for MOX batches up to 200 kg in size, a size suitable for ensuring uniformity of MOX pellets and reasonable analytical costs. Smaller MOX batches can be processed to produce small numbers of pellets of various enrichments.

4.3.2.5 Characteristics of proposed facilities for processing

The space proposed is an operating S&S Category I fuel fabrication facility designed for processing highly enriched uranium. ANL-W is pursuing a program that would upgrade the FMF structure to meet plutonium-processing standards in 1998. The space proposed for the powder and pellet-processing area would be cleared of nuclear materials to allow modifications and installation of process equipment in a noncontaminated work area. The space proposed is toward the minimum required for the LA project. Some additional upgrading and installation of an HVAC system in the powder and pellet-handling area would be required.

4.3.3 Safety-Related Attributes

4.3.3.1 NEPA compliance

MD is preparing a site-specific EIS that is intended to be sufficient for conducting the LA project at any of the candidate sites without further NEPA actions. Some risk exists that unspecified process or facility changes might require additional action. It is anticipated that any site selected would need to prepare supporting documentation to ensure that the EIS includes bounding case scenarios for the site-specific process and design. Additional NEPA action, if required, could delay the LA project.

4.3.3.2 Safety bases

The FMF and ZPPR facilities are both Hazard Category 2 nuclear facilities. The FASB facility at ANL-W is classified as a radiological facility. It would be upgraded to a Hazard Category 2 nuclear facility with minimal effort. The FMF plans to have an approved DOE 5480.23-format SAR in 1999. A new DOE 5480.23-format SAR is planned for ZPPR, but it probably would not be completed in 1999. The FASB facility proposed for bundle assembly would have a new DOE 5480.23-format SAR prepared.

4.3.3.3 Operational readiness review

A DOE ORR, performed in accordance with DOE Order 425.1, will involve self-assessment, contractor-independent assessment, and support to the DOE ORR team. An interim review is expected for use of uranium in the process before introducing plutonium. A single team likely would review all facilities used in this option. ANL-W staff has recent experience in performing ORRs.

4.3.3.4 DOE Order compliance

The proposed LA project will be regulated by DOE but led by the consortium. The consortium may be unfamiliar with DOE regulations and would expect the host site to ensure smooth, compliant operation. Furthermore, the project likely would be closely scrutinized by NRC and the regulatory offices of the consortium utility. The site would be responsible for ensuring regulatory compliance.

The ANL-W team demonstrated awareness of the need for rigorous compliance with applicable requirements and has based a significant portion of ongoing upgrades and modifications on ensuring compliance with DOE Orders.

4.3.3.5 Compliance with plutonium-processing and -handling facility design criteria

ANL-W has designed upgrades to qualify FMF to the DOE requirements for plutonium processing. ANL-W plans to complete these modifications in 1998 with existing program funding. The modifications include upgrading the ventilation system to meet criteria for seismic qualification. The staff and management demonstrate understanding of and compliance with PPHF criteria.

4.3.4 Safeguards and Security-Related Attributes

4.3.4.1 Physical protection

All of the facilities (FMF, FASB, and ZPPR) are located in close proximity to each other inside a relatively small area that was formerly a PA but is currently being treated as the ANL-W PPA. The fenced PPA has only one operational entrance via a guard post equipped with metal and SNM detectors and X-ray machines. Anyone entering this area is checked for contraband and access authorization. Protective forces are located on the ANL-W site. Most of the facilities selected for the MOX activities have significant barriers that were designed primarily for safety considerations associated with earlier missions. The FMF and ZPPR are S&S Category I areas that are located within the ANL-W PA and meet the requirements to protect Category I quantities of SNM. They have hardened doors, multiple security portals, and in many cases, double safety barriers. Only the warehouse outside the ZPPR workroom is less robust, but it is still within the PA. When doors to the ZPPR reactor cell are open, security personnel are present. Some minor physical protection upgrades may be necessary for FMF and the ZPPR reactor cell and workroom (e.g., cameras and detectors), but they should not be significant. Most of the necessary upgrades would be for the FASB, which is currently an S&S Category III area located within the PPA. Because the activities within this building involve only bundle assembly, the upgrades should not be extensive. Two additional security personnel would be required to cover all of the areas and to support SNM shipping and receiving. Few requirements exist for new S&S equipment; hence, the level of effort to test and validate these systems should be minimal.

4.3.4.2 Material control and accountability

A preliminary MC&A and nuclear measurement assessment of the material flow has not been done. An MC&A plan would need to be developed. The MOX fuel fabrication processes have not been evaluated to define the key measurement points and the sampling and measurement plans. The MC&A custodian most likely would be a member of the MOX process staff. Two people would need to be added to support the MC&A functions. These people would also help in the packaging and shipment activities and the internal transfers of the SNM.

On-site analytical laboratories, as well as available NDA capabilities, exist to support the receipt and accountability of the PuO_2 and other bulk material (MOX powders and pellets). The MC&A measurements generally would be done in the ZPPR workroom. NDA capability exists except for a rod scanner, which would be procured. NDA testing equipment, including calorimetry and gamma and neutron counting, is located in the ZPPR workroom. A glove box neutron measurement capability is planned. Standards would need to be developed for the NDA measurements.

4.3.4.3 Vulnerability assessment and site safeguards and security plans

An assessment has been conducted for necessary S&S upgrades to support the LA project. A preliminary VA has been performed. The site is currently protecting targets that are more attractive than the LA project targets against the same likely threats; therefore, it is not envisioned that the operations required for the LA project would significantly impact the facility VAs. The primary area that would need further analysis is the bundle assembly area located in FASB. Because on-site transportation would consist of only movement of wastes and samples to and from the on-site analytical laboratories, the risk of SNM movement should not be significant. An SSSP exists, is updated annually, and includes a VA. The impact of the LA project on the site SSSP and VA would need to be evaluated and necessary changes made to the documents during the preproduction period. Thereafter, the impact of the LA project would be included in the annual reviews.

4.3.4.4 Radiological sabotage potential

It is not clear if the RADSAB assessment limits are beyond the criticality limit in this option. It is assumed that criticality limits may be up to 10 kg of PuO_2, resulting in MOX batch sizes up to 200 kg.

4.3.4.5 Access by foreign nationals and uncleared personnel

The MOX fuel fabrication processing and rod fabrication in FMF and bundle storage in the ZPPR reactor cell would be in a PA and an MAA. The rod storage and single bundle storage in FASB is currently within the PPA, but it would become a limited area once SNM is present. Uncleared personnel would require escorts within the limited area, PA, and MAA. Plans for escorting foreign or uncleared visitors would be developed. No classified, sensitive, or nuclear weapon items that must be protected are located within the area that is visible to a visitor.

4.3.4.6 Special nuclear material storage

The PuO_2 would be received and stored initially in the ZPPR vault. The ZPPR Mock-up Building would be used to store DUO_2. Both would require minimal modification to accommodate the LA project. Items would be consolidated and removed to make room for the PuO_2 in the ZPPR vault. In addition, contents of the FMF vault would be moved to the ZPPR vault, some storage racks would be removed, and two temporary walls would be removed. Some containers are available, but additional containers may be needed to consolidate the storage and release the existing FMF vault for MOX powder and pellet processing.

The PuO_2 would be moved to the FMF processing area where the oxide would be blended and made into pellets and the rods would be filled. The powder processing would be located within an existing vault, and the oxide, blended powders, pellets, and rods would be stored in this location.

The rods would be temporarily stored in this area and then moved to the FASB, currently a Category III area, for the bundle assembly. Only one bundle may be stored in FASB. Otherwise, the bundles will be stored in the ZPPR reactor cell. The ZPPR reactor cell may require minor reconfiguration for installation of bundle storage racks. The FASB vault would need some modification to provide storage capability for rods and bundles.

4.3.4.7 Other safeguards and security characteristics

Other S&S programs are in place, and some personnel have the required security clearances for accessing Category I quantities of SNM. Several other staff members would need upgrades to their clearances. The added security personnel also would need clearance upgrades (if they did not have them) and enrollment in the PSAP. Ten new clearances or upgrades are expected to be required.

4.3.5 Other Attributes

4.3.5.1 Site infrastructure available to support the LA project

Suitable site infrastructure for the LA project either is available to the proposed operating area or can be provided with minor administrative or equipment upgrades. These infrastructure items include S&S; MC&A; analytical laboratory capability; fire protection; medical services; emergency response and control centers; water, sewer, and utilities; and waste management.

4.3.5.2 Off-site transportation

The PuO_2 would be delivered by DOE SST vehicles and would be received at the ZPPR warehouse adjacent to the ZPPR workroom. Loading and unloading would involve the SST facilities and current ZPPR functions, including shipping and handling support, initial receipt measurements, and security forces. The area does not have overhead cover, but this should not be a significant problem. The material would be swiped for contamination, received, and moved into the ZPPR workroom for the NDA measurements. The FMF also has the capability to handle SSTs. DUO_2 powder will be received and stored in the ZPPR area until needed in FMF.

Partially filled bundles containing rods of LEU would be received at the FASB. Shipping packages containing the incoming bundles would be unloaded from trucks at the dock and moved into either the FASB or the ZPPR area for storage.

Packages containing bundles with various loadings of MOX fuel would be shipped to the reactor site via commercial truck or SST from the FASB dock. It is assumed that DOE would provide certified shipping containers, probably the MO-1, for bundles containing MOX fuel rods. The dock has no concealing cover to accommodate S&S shipments, but this should not be a major problem. Some minor upgrades may be needed for the FASB loading area if SSTs are used to ship the bundles containing MOX.

If the SSTs must be left overnight, they can be parked and left unattended in the ANL-W PA.

4.3.5.3 On-site transportation

Except for waste removal, the only on-site moves of SNM would be between adjacent buildings. These movements, using carts or small trucks, would occur within the ANL-W PPA (inside a very small, well-protected fenced area with restricted access) and mostly within the PA. Security personnel would accompany the movements of SNM. PuO_2 would be moved from the ZPPR storage vault to the FMF processing area, rods would be moved to the FASB from the FMF, and bundles would be moved to the ZPPR reactor cell from FASB. Protective containers would be needed for the movement of the rods. The primary effort would be the evaluation of the requirements for moving the rods and obtaining or fabricating the necessary containers.

4.3.5.4 Formal design methodology

The ANL-W organization has an established facility engineering function that is well-versed in DOE design criteria.

4.3.5.5 Waste management

The INEEL site has qualified waste management processes that are expected to be adequate for the needs of the LA project. The site has the capability to process and certify TRU waste for future disposal in WIPP and currently handles and stores significant quantities of TRU waste on site. Solid LLW and mixed waste are also routinely handled and either stored for disposal off site or disposed of on site. The infrastructure exists for the handling and processing of liquid radioactive wastes. The impact of the LA project on waste operations at INEEL appears to be well within the scope of existing capabilities.

An agreement with the State of Idaho places restrictions on the inventory and disposal of plutonium on the INEEL site. The impact of this agreement would have to be considered in planning logistics and schedules for the LA project.

4.3.5.6 Radiation protection

All sites have comparable ALARA goals for radiation workers. The ALARA goal at INEEL for new missions is a group average of 500 mrem/year compared to the current goal of 750 mrem/year.

4.3.5.7 Decontamination and decommissioning

ANL-W expects to remove and dispose of some contaminated equipment items, decontaminate the glove boxes, and leave the glove boxes and other equipment and instruments in place at the close of the project. INEEL and ANL-W have experience in the decontamination of glove boxes. ANL-W considers having a MOX fuel fabrication process line an asset for future missions.

5. HANFORD

5.1 DESCRIPTION OF THE HANFORD SITE

The Hanford Site is located near Richland, Washington, in the southeastern portion of the state. The 560-$mile^2$ site supports programs in waste management, environmental restoration, science, and energy.

Hanford was established in secrecy during World War II to produce plutonium for America's nuclear weapons. Peak production years were reached in the 1960s when nine production reactors were in operation at the site. All weapons material production was halted in the late 1980s; however, significant quantities of SNM are still stored at the site. The site is now engaged in the world's largest environmental cleanup project.

In addition to the production of plutonium for the nation's defense needs, Hanford has extensive experience with MOX fuel. Hanford performed the engineering, development, and fabrication of MOX fuels for FFTF.

Current activities at Hanford include the Light-Water Reactor Tritium Target Qualification Project, a project led by PNNL to produce hardware for demonstrating the feasibility of producing tritium in commercially owned and operated nuclear reactors.

The Hanford infrastructure, including facilities, trained personnel, and active programs, is suitable to support the fabrication of MOX fuel for the LA project at FAA. FAA would require upgraded security and SNM controls during its activation; however, sitewide services are in place and suitable to support the LA project. These sitewide services include utilities; intrasite transportation; security; fire protection; chemical and radiological waste handling, storage, and disposal; analytical laboratories; emergency response; medical, health, radiation protection, dosimetry, and personnel decontamination programs; laundry service; fitness for duty and training programs; nuclear facility safety programs; environmental monitoring programs; environmental and regulatory compliance systems; and integrated safety management systems.

5.2 FACILITIES AND PROCESSES PROPOSED FOR THE HANFORD OPTION

5.2.1 Facility Descriptions

The Hanford proposal for fabricating MOX fuel for the LA project calls for the use of FAA, Building 4862, and PFP, Buildings 2736ZA and 2736ZB. FAA adjoins the larger Building 427, FMEF, and is located in the Hanford 400 Area near FFTF. All of the MOX fuel fabrication would occur in FAA. PuO_2 would be received and stored initially in vaults in PFP until needed at FAA. Some existing analytical laboratories in Building 325 or in PFP also would provide analytical support to the process.

FAA has about 18,000 ft^2 of floor space and is a self-sufficient, hardened Safety Class 1 structure, adjacent and appended to the southeastern end of FMEF. FAA was designed and constructed to house the final assembly of MOX fuel assemblies for FFTF. The building structure and safety-related equipment and systems are designed to withstand earthquake, tornado, high winds, and volcanic ash fall events. FAA is a clean, unused facility, with more than adequate available space, that can be refitted quickly and easily to meet the requirements for LA fabrication. The SET analysis was conducted on the basis that the potential use of FAA was contingent on FMEF being engaged in another compatible mission. Hanford management has subsequently indicated that FAA could be used without regard to the status of FMEF. Although appended to the FMEF, FAA has its own ventilation, electrical, and most other systems. Thus, if needed, FAA can be operated largely independent from FMEF.

In 1991, an extensive engineering study was performed FAA to define the changes to FAA needed to manufacture MOX fuel for FFTF. The PSAR from the 1991 study provides engineering information for planning the use of FAA for fabricating MOX fuel for the LA project. Modifications to FAA that would be required by the LA project are minimal except for installation of Zone 1 ventilation capability. FAA has large open areas that allow for flexibility in arranging glove boxes and partitions for optimum process flow. Operations with PuO_2 powder would require an additional bank of HEPA filters to provide Zone 1 capability for glove box operations. This ventilation upgrade was defined in the 1991 engineering study and can be implemented without significant technical or fiscal risk. The proposed spacious area is in a structure that is completely constructed, well maintained, radiologically uncontaminated, and lightly secured. These factors should allow optimum process line layout and should permit efficient design and construction with predictable cost and schedule. The existing PIDAS and security facilities that serve FMEF and FAA will need to be upgraded, tested, and activated to permit operation of FAA as an S&S Category I facility. Modest security refinements also would be required inside FAA.

Nondestructive assay and short turnaround (in-process) analytical capability would be included in Building 4862 fabrication areas. The analytical laboratory facilities currently operating in PFP, located in the 200 West Area, or Building 325, in the 300 Area, would provide the primary analytical support for the LA project.

Waste from FAA would be dispositioned at the Hanford Site Central Waste Complex.

5.2.2 Process Descriptions

5.2.2.1 Powder receipt and storage

The PuO_2 would be received and stored initially at PFP. PFP, Buildings 2736ZA and 2736ZB, are located in the 200 West Area and currently are used for secure storage of S&S Category I quantities of plutonium.

PFP is capable of receiving and storing all of the PuO_2 needed for the LA project in a single SST convoy shipment. The feed PuO_2 would be received at the PFP vaults, receipt verification and SNM accountability would be performed, and the PuO_2 would be stored in unopened containers in the vaults awaiting intrasite movement to FAA. The PuO_2 containers would not be opened until they reach FAA; thus, the PFP vaults would operate as pass-through facilities with respect to MC&A. Hanford has proven processes and equipment in place for the intrasite movement of radioactive materials. DUO_2 powder probably would be received via commercial carrier.

Subsequent to the SET evaluation, Hanford management proposed receiving and storing PuO_2 powder in FAA. Under the revised plan, which has not been evaluated by SET, PuO_2 would be received and stored in FAA. Trucks would be unloaded in the FAA truck lock. Hanford states that FAA is capable of receiving and storing all of the PuO_2 needed for the LA project in a single shipment. FAA would perform receipt verification and SNM accountability and then store the unopened containers in tube vaults in the fuel storage pit. DUO_2 also would be received and stored in FAA.

5.2.2.2 Powder, pellet, and rod fabrication

MOX fuel for the LA project would be fabricated in a glove box line using a batch-type process composed of discrete processing steps. A typical batch is expected to begin with about 3 to 5 kg of PuO_2. The process would be able to accommodate smaller batches of MOX fuel for plutonium concentrations requiring a small number of pellets. The specific processing steps include blending and milling of PuO_2 and DUO_2 powders to produce a 30% PuO_2 master mix, final powder blending (nominally 5% PuO_2), granulation, pellet pressing, pellet sintering, pellet grinding, rod loading, rod welding, and bundle assembly. These discrete processing steps include applicable in-process tests and inspections necessary for process control and product certification. Segregation of materials at processing hold points would be necessary to ensure proper material and quality control.

5.2.2.3 Interim storage of powder and pellets

Glove boxes and shipping packages would be used for in-process storage of blended powder, green and sintered pellets, and reject or scrap material. If the vault in the adjoining FMEF is activated by another compatible program, it too may be used for in-process storage.

5.2.2.4 Interim storage of rods

Fuel rods placed in sealed trays with supports would be stored on racks or floor vaults in the FAA until they are needed for bundle assembly.

5.2.2.5 Bundle assembly and inspection

Bundle assembly and inspection would be performed in the high-bay area of FAA.

5.2.2.6 Bundle storage

Nonradioactive rod and bundle hardware and partially filled bundles containing LEU fuel supplied by the consortium would be received and stored in FAA. Bundles containing various loadings of MOX also can be stored in FAA either in secure racks or modified floor vaults until ready for shipment.

If needed, completed assemblies also could be stored in available space in PFP. The PFP vaults have significant excess capacity and can meet all of the requirements of the LA project mission without modification.

5.2.2.7 Handling of consortium-supplied hardware

The site would receive and store consortium-supplied hardware until needed in the fabrication process. The consortium is expected to supply (1) sufficient rod hardware to produce rods loaded with 3 MT of MOX fuel (approximately 1500 rods plus spares) and (2) fuel bundles partially filled with LEU rods. Also, the consortium may choose to supply process equipment or tooling.

5.3 CHARACTERIZATION OF THE HANFORD FAA OPTION

5.3.1 Project-Level Attributes

5.3.1.1 Facility and mission compatibility

Hanford proposed the use of FAA, Building 4862, for fabricating MOX fuel for the LA project. The building currently has no mission assignments and no identified conflicts. The LA project alone would not justify the activation of FAA and the adjoining FMEF complex for plutonium processing. Hence, a compatible mission for the adjoining FMEF is needed for the FAA building to be committed by site management for the LA project. In the event that an existing proposal to fabricate FFTF MOX fuel or one or more other possible uses being considered for FMEF is exercised, FAA becomes viable for the LA project. Unfortunately, the enabling FMEF project(s) could conflict with the proposed LA project unless steps are taken to ensure noninterference.

In the plan presented to and evaluated by SET, Hanford maintained that the LA project alone would not justify the activation of FAA and the adjoining FMEF complex for plutonium processing. Subsequent to the SET evaluation, Hanford management indicated their decision that FAA could be committed to the LA project regardless of the status of FMEF. The absence of a compatible mission for FMEF would raise the cost of operating FAA since FAA then would have to bear the total cost of operating the complex. In the original plan, SET foresaw the need for careful coordination between FAA and FMEF to avoid potential conflicts that could impact FAA activities. Hanford indicated that their analyses show the missions being considered for FMEF to be compatible with executing the LA project in FAA. Although FMEF and FAA are joined and share some common resources, the facilities are configured to permit a high degree of operational independence. However, SET has not seen the recently cited analyses that demonstrate mutuality of the proposed projects.

5.3.1.2 Cost and cost risk

The reference cost estimate for the Hanford FAA option for the LA project is $77M in constant FY 1998 dollars. The reference case contains data that incorporate comments by the site. After reviewing data from all the options, SET identified indeterminate factors that could cause the estimate to increase or decrease and used these factors with the reference case values to establish a cost range for the Hanford option. Figure 8 shows the ranges of estimated cost by project phase for the Hanford option. The adjustment factors are discussed below and summarized in Table 13. All costs are given in millions of unescalated FY 1998 dollars.

After studying the data provided by each site for burdened labor rates and other cost factors such as user fees, space charges, and program loads, SET adjusted the labor rates and various fees used in the project models for each option to provide the most direct cost comparison possible among the options. By applying this process, SET computed an adjustment for the Hanford option that decreased the costs associated with space charges by $18.3M and increased the costs associated with labor rates by $25.8M. The net adjustment is a negative $3.2M during the standby phase.

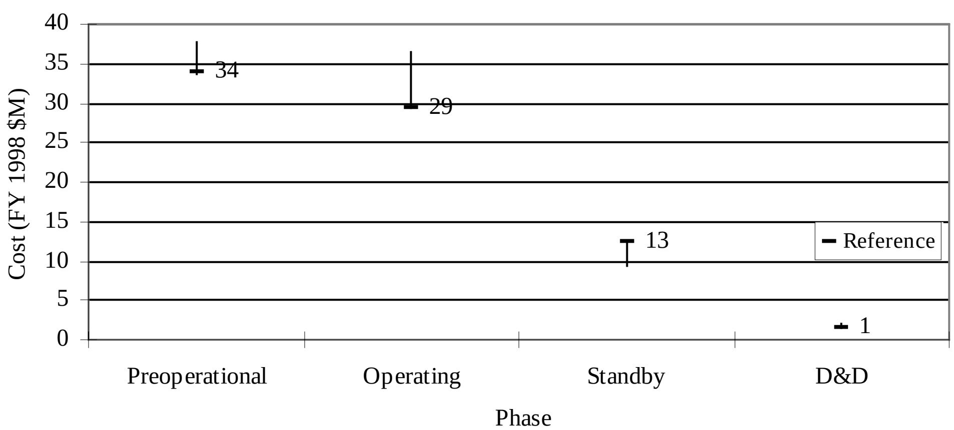

Fig. 8. Cost ranges by phase for the Hanford option.

Table 13. Cost adjustments for the Hanford option by project phase

Factor	Cost adjustment ($M) Project total	Preoperational phase	Operational phase	Standby phase	D&D phase
Space charges	-18.3	-4.9	-6.6	-6.8	0.0
Labor rates	+25.8	+7.8	+13.8	+3.6	+0.7
Schedule reduction	-0.3	-0.3	0.0	0.0	0.0
Site security	+0.8	+0.8	0.0	0.0	0.0

A factor that could lower project cost would be the shortening of the preoperational phase of the project. Unfortunately, the facility must undergo a complete startup and thorough readiness review before it could be utilized for MOX production. The startup activities could proceed relatively efficiently because the site currently has a relatively low level of security. During the time period of the proposed LA project, one or more other projects are expected to be undergoing startup in the adjacent FMEF building. Coordination of the two or more projects without introducing delays to any one of them would be challenging. SET estimated that the FAA option could be shortened by only two months. Further, SET estimated savings of approximately $0.3M for the potential schedule improvement. Hanford personnel expressed their belief that SET has overemphasized the facility startup activities and the potential coordination problems with prospective missions for the adjoining FMEF and, consequently, has underestimated the possible schedule improvement for their option.

A factor that could produce upward pressure on costs is the possible negative interaction with other prospective missions for FMEF. Introducing plutonium into FAA is unlikely for the limited production of the LA project unless FMEF is likewise host to a mission with plutonium-processing activities. Several potential assignments for FMEF are under consideration. The requirements of these potential FMEF projects vary and could have different influences on performing the LA project in FAA. The relative portion of the combined FAA and FMEF facility overhead costs that would be borne by FAA depends on the nature of the use made of FMEF. No cost adjustment was made for this factor.

The costs to upgrade, activate, and test the PIDAS security systems and guard posts for the FAA-FMEF complex were not included in the LA project reference case estimate. It was assumed that the larger FMEF projects would fund these activities. SET made a cost adjustment of $0.8M to the Hanford reference case to include these costs.

5.3.1.3 Schedule and schedule risk

The schedule developed by SET in collaboration with the Hanford FAA team shows that this option can meet the June 2003 milestone for the fabrication of the first qualified MOX rod.

As mentioned in Sect. 5.3.1.1, during the SET evaluation, Hanford management maintained that, for the FAA option to be considered viable, at least one compatible mission was needed for FMEF. Subsequently, Hanford has stated that compatible assignments for FMEF are desirable but not essential for FAA to perform the LA project. Each mission being considered for FMEF would pose a different set of interfaces and potential schedule conflicts with the proposed FAA-based LA project. FAA can be decoupled to a large extent from the adjoining FMEF; however, some direct interface with other prospective missions and concomitant risk to the FAA schedule is inevitable unless careful planning and coordinated management of the two (or more) projects are established to preclude conflict. Hanford personnel indicated that their planning shows that several missions being considered for FMEF could coexist with the LA project in FAA without significant interference and with minimal schedule impact. Although FAA adjoins and interconnects with FMEF, it is largely self-sufficient and can be accessed independently.

Some aspects of the FAA option present a clear opportunity to accelerate the LA project schedule and produce the first qualified rod much earlier than the June 2003 milestone. One factor is that FAA was originally designed to produce MOX fuel. Thus, with a few previously noted exceptions, FAA currently is suitable to host the LA project. Second, although FAA is not operating, it is spacious, clean, and well maintained. These conditions would permit efficient design of an optimum process. Modifications could begin as soon as a compatible mission for FMEF is ensured and planned. Furthermore, FAA modifications can be performed efficiently because of the open, unimpeded space and current modest levels of security.

Unfortunately, negative schedule aspects exist, too. FAA is not an operating facility and was constructed several years ago. Consequently, all the systems designed to ensure safe processing of plutonium must be checked and modified or upgraded as needed then activated, adjusted, and demonstrated to be satisfactorily functioning. No major problems are anticipated in starting up these systems; however, a significant amount of work is demanded to rigorously and systematically check out and start up all the systems needed to achieve and demonstrate safe operational status. After considering all of these factors, SET concluded that significant improvement in the preoperational schedule is unlikely and assigned only a 2-month schedule improvement to the Hanford FAA option. The related cost savings are estimated to be $0.3M.

5.3.1.4 Quality assurance program

The staff that currently operates FMEF and FAA has no recent, direct experience of producing reactor hardware under the control of NRC QA requirements contained in 10 CFR 50, Appendix B. However, another Hanford organization recently produced tritium targets in compliance with the NRC QA requirements of 10 CFR 50, Appendix B. These components were approved by NRC for installation in a reactor owned and operated by a U.S. utility. Although the tritium target components are different from MOX fuel, the NRC and utility QA lessons learned likely are transferable to the FAA team.

5.3.2 Operational Attributes

5.3.2.1 Production-processing approach

The spaces proposed for this option have no significant physical or operational characteristics that would prevent the design and implementation of an efficient, pilot-scale process. The process is expected to be able to meet requirements for equipment, batch size, and QA. The FAA team indicated that their process could be based on either campaigning batches or steady-state processing in accordance with the desire of the consortium.

5.3.2.2 MOX fuel fabrication experience

The Hanford site has extensive, successful MOX experience, mainly in the production of fuel for FFTF. This experience includes procurement of FFTF cores from two NRC-licensed MOX fuel manufacturers and, in the 1960s and 1970s, the development of MOX fuel for LWR plutonium recycle programs. The FFTF MOX fuel fabrication experience is relevant to the proposed LA project. Several personnel with FFTF MOX experience still work at Hanford.

5.3.2.3 Existing prototypic process equipment

FAA currently has no prototypic MOX processing, bundle assembly, or analytical equipment. FMEF has an unoperated MOX fuel fabrication line containing several pieces of unused equipment. Existing fuel storage pits in FAA can be modified to accommodate the MOX fuel bundles for the LA project. Sophisticated analytical equipment needed to support the LA project exists and is fully operational in the PNNL-operated Building 325 laboratory. Several dedicated analytical instruments would be installed in FAA to provide support for process control and product certification.

5.3.2.4 Batch size flexibility and analytical optimization

The FAA team proposed batches of MOX up to 100 kg in size. The consortium may prefer larger batches to ensure feed homogeneity and lessen analytical costs; however, 100-kg batches should be large enough to ensure acceptable product uniformity and avoid excessive analytical costs. Smaller MOX batches can be processed when needed for small campaigns.

5.3.2.5 Characteristics of proposed facilities for processing

The space proposed is within a facility specifically designed to fabricate MOX fuel. The facility has never been contaminated. No features restrict the installation of prototypic process equipment into an efficient productionlike line. The space proposed is larger than the minimum required for the LA project. Few modifications are required (e.g., partition walls, drop ceilings, floor coverings, and HVAC) to accommodate the proposed FAA MOX fuel process line.

5.3.3 Safety-Related Attributes

5.3.3.1 NEPA compliance

MD is preparing a site-specific EIS that is intended to be sufficient for conducting the LA project at any of the candidate sites without further NEPA actions. There is some risk that unspecified process or facility changes might require additional action. It is anticipated that any site selected would need to prepare supporting documentation to ensure that the EIS includes bounding case scenarios for the site-specific process and design. Additional NEPA action, if required, could delay the LA project.

5.3.3.2 Safety bases

The adjoining FMEF and FAA facilities, built to manufacture MOX fuel, were designed and constructed to DOE standards for processing and handling plutonium. The facility has never been activated as a nuclear facility and does not have a current SAR; however, facility structural analyses documented in the facility PSAR show that the facility surpasses requirements for natural phenomenon hazards. Hanford plans to use these PSAR materials to create a DOE 5480.23-format SAR to address the use of FAA for the LA project.

The PFP facility vaults for feed material storage are Hazard Category 2 and have an approved DOE SAR that was prepared to draft DOE Order 5480.23 guidance.

5.3.3.3 Operational readiness review

A full DOE ORR likely would be required before the introduction of any radioactive material into the noncontaminated FMEF or FAA. A DOE ORR, performed in accordance with DOE Order 425.1, would involve self-assessment, contractor-independent assessment, and support to the DOE ORR team. Because this facility has never operated, the readiness review would address all the MOX processes, including all FAA functions and FAA interfaces with site infrastructure.

Vault storage of feed material in PFP would require a minimal readiness assessment because it currently is an operating vault for PuO_2 storage.

The Hanford site has staff experienced in conducting ORRs.

5.3.3.4 DOE Order compliance

The proposed LA project will be regulated by DOE but led by the consortium. The consortium may be unfamiliar with DOE regulations and would expect the host site to ensure smooth, compliant operation. Furthermore, the project likely would be closely scrutinized by NRC and the regulatory offices of the consortium utility. The site would be responsible for ensuring regulatory compliance.

The Hanford team demonstrated support for rigorous compliance with applicable requirements.

5.3.3.5 Compliance with plutonium-processing and -handling facility design criteria

The FMEF and FAA facilities were designed and constructed to standards for plutonium-processing and -handling facilities, but they were never activated as nuclear facilities.

The PFP facility vaults are DOE-approved facilities for storage of plutonium. The staff and management demonstrate understanding of and compliance with PPHF criteria.

5.3.4 Safeguards and Security-Related Attributes

5.3.4.1 Physical protection

FAA is a hardened building that adjoins the east side of FMEF. FAA is located within a PIDAS. However, the PIDAS and guard station currently are not operating and would have to be upgraded and reactivated for FAA to operate as an S&S Category I facility. Within FAA, few S&S systems currently exist. Consequently, equipment such as detection sensors, cameras, barriers, and access control measures would be needed. The site has estimated the upgrade requirements based on earlier work done for a conceptual design. Any existing systems that are to be used in support of the MOX mission, as well as all new systems and components, would need to be tested and validated. This would include validating the conclusions of the VA. Thirteen additional security personnel have been identified for access control, surveillance patrols, and support of SNM shipping, receiving, and movement.

5.3.4.2 Material control and accountability

The Hanford FAA plan presented to and evaluated by SET called for PuO_2 feed material to be delivered to and stored in an operating SNM storage vault in PFP. Subsequent to the SET evaluation, Hanford management decided to use existing, unused tube storage vaults in FAA for PuO_2 storage rather than use the PFP vaults. The revised plan appears to be slightly more favorable; however, the SET evaluation is based on the use of PFP for material accountability for the initial receipt of the PuO_2 and for SNM storage in the existing vault. An analytical laboratory, which is some distance from the processing area, would support the NDA and DA testing. MC&A and NDA support would be required, particularly at the bulk MOX processing. A preliminary MC&A nuclear measurement assessment of the material flow has not been done. No MC&A plan currently exists for the proposed facilities, and a preliminary plan has not been developed. Two technicians for MC&A support are included in the reference case estimated for this option.

No NDA or DA capability currently exists at FAA. The plan is to use available capabilities located elsewhere on the Hanford site. If NDA capability is not collocated near the processing area, then the impact on operations and additional transportation costs for the samples as well as meeting MC&A requirements must be considered. It is probably necessary that FAA have at least a rod scanner, but preferably a calorimeter, gamma and neutron counters, and a rod scanner would be procured and installed in FAA.

5.3.4.3 Vulnerability assessment and site safeguards and security plans

Preliminary S&S plans have been developed, and these include earlier work done in the early 1990s for the FFTF MOX fabrication facility. More effort would be required to evaluate these plans and prepare more detailed plans as the project progresses. Specific S&S needs were developed but should be reviewed with respect to this mission. A site VA exists for the PuO_2 storage vault. A VA has not been done for the FAA building. The LA project is not expected to have a significant impact on the existing VA for PFP. The risk for theft or radiological sabotage from the FAA processing area must be assessed. The fact that FAA is a large, hardened building in a relatively remote location would affect the radiological sabotage and dispersion analysis. Because FAA is not an operating plutonium-processing facility and has little or no S&S measures in place, it would initially require a more extensive VA. In addition, the risk for SNM transport needs further evaluation. The SSSP would need to be revised to reflect this new mission.

5.3.4.4 Radiological sabotage potential

The initial plan for this option called for a limit of 6 kg of PuO_2 to be available or at risk. Later, the option was modified to be an S&S Category I option, and the expected quantities of in-process PuO_2 increased to approximately 10 kg/glove box.

5.3.4.5 Access by foreign nationals and uncleared personnel

All of the proposed MOX processing and MOX fuel storage locations are in a single hardened building, the FAA. After construction to install the MOX process equipment, this building would be operated as an S&S Category I facility inside a reactivated PIDAS. Until then, the current PPA controls would permit more efficient access for design teams, consortium staff members, construction forces, and equipment installers. After S&S Category I controls are activated, uncleared personnel would require escorts. No classified or sensitive items are expected to be present in FAA; hence, visitor controls are expected to be minimal. Some projects that are being considered for FMEF involve classified or other sensitive materials to which access must be restricted. Because FMEF interconnects with FAA, controls to prohibit access of FAA workers and uncleared visitors to selected areas of FMEF would need to be implemented.

5.3.4.6 Special nuclear material storage

The PuO_2 for the LA project would be received and stored at the plutonium storage vault located at PFP. As needed to support the process, the oxide would be moved to the processing area where it would be stored within the processing line along with the blended powders, pellets, and MOX rods. The completed bundles would be stored in vertical tube vaults located in the FAA floor. The LA project would require no modifications to the plutonium storage vaults in PFP. Minor modification of the FAA tube vaults would be required. Containers for movement and storage of rods would be fabricated.

5.3.4.7 Other safeguards and security characteristics

Other S&S measures are in place at the site to support the LA project. There are additional security clearance and PSAP requirements. An estimated 40 personnel would need to get clearances, and some also would need to be enrolled in PSAP.

5.3.5 Other Attributes

5.3.5.1 Site infrastructure available to support the LA project

Suitable site infrastructure for the LA project either is available to the proposed operating area or can be provided with modest administrative or equipment upgrades. These infrastructure items include S&S, MC&A, analytical laboratory capability, fire protection, medical services, emergency response and control centers, water, sewer and power, and waste management. Hanford assumed that upgrading the perimeter security of the FAA-FMEF area would be borne in whole or large part by the FMEF.

5.3.5.2 Off-site transportation

As stated in Sect. 5.3.1.1, the original plan for the Hanford FAA option called for delivery of the PuO_2 feed material to PFP, which has the capability to receive SSTs sufficient to support the LA project. Subsequent to the SET evaluation, Hanford management decided to use the FAA tube storage vaults for PuO_2 powder storage. FAA has a fully enclosed truck lock suitable for shipping and receiving all LA production materials. In addition, when security systems are activated, hardened truck locks located in FMEF could be used for unattended parking of SSTs. The FAA facilities have never been used for fuel shipments and would require minor modification and equipment, such as material accountability systems and handling equipment, before being placed into service.

5.3.5.3 On-site transportation

Except for small laboratory samples and waste, the only on-site movement of radioactive materials required for this option would be from the storage vault at PFP to the processing area in FAA. The distance between these two locations is approximately 10 miles. The movements would be over controlled access roads that are accessible by the public. During the moves, the public access to the roads would be restricted. The site has experience in moving SNM within the site. Transport, escorts, and procedures are already in place for such moves. Up to 25 trips may be necessary between PFP and FAA.

The site has proven techniques for the intrasite movement of laboratory samples and waste materials. These techniques are pertinent and available to the FAA operations.

5.3.5.4 Formal design methodology

The Hanford Site has an established facility engineering function that is well-versed in DOE design criteria.

5.3.5.5 Waste management

The Hanford Site has existing capabilities to manage and dispose of waste that are expected to be adequate for the needs of the LA project. The site has a new facility to process TRU waste for future disposal in WIPP and currently handles and stores significant quantities of TRU waste onsite. Solid LLW and mixed waste (MW) also are handled routinely and either stored for disposal offsite or disposed of onsite. The impact of the LA project on waste operations at Hanford appears to be well within the scope of existing capabilities.

5.3.5.6 Radiation protection

All sites have comparable ALARA goals for radiation workers for new missions. The ALARA goal for a new mission at Hanford is a group average of 500 mrem/year compared to the current goal of 600 mrem/year.

5.3.5.7 Decontamination and decommissioning

The reference case cost estimate for FAA assumes the removal of unneeded equipment, wiping of glove-box interiors, disposal of waste, and retention of glove boxes and other items for future projects. Hanford has experience in the decontamination of facilities.

6. LAWRENCE LIVERMORE NATIONAL LABORATORY

6.1 DESCRIPTION OF THE LLNL SITE

LLNL is located near Livermore, California, about 50 highway miles southeast of San Francisco. The 1.3-mile^2 complex is currently self-described as a national security laboratory.

LLNL began in 1952 as a second laboratory for the expanding weapons program. Its history includes numerous contributions to materials science, computing, and weapons research, design, and testing. Currently, the laboratory focuses on stewardship of the U.S. nuclear stockpile, stemming the proliferation of weapons of mass destruction, and other missions of national importance where the laboratory feels it can make unique and important contributions.

In addition to its current weapons program R&D, LLNL is conducting research in support of the DOE MD program to disposition surplus weapons-usable plutonium. LLNL collaborates in R&D activities with LANL in the ARIES program to convert weapons pit parts to plutonium oxide and with SRS and others in the plutonium immobilization alternative.

The LLNL site infrastructure, including facilities, trained personnel, and active programs, is suitable to support the fabrication of MOX fuel for the LA project. Sitewide services are in place and suitable to support the LA project. These sitewide services include utilities; intrasite transportation; security; fire protection; chemical and radiological waste handling, storage, and disposal; analytical laboratories; emergency response; medical, health, radiation protection, dosimetry, and personnel decontamination programs; site laundry; fitness for duty and training programs; nuclear facility safety programs; environmental monitoring programs; environmental and regulatory compliance systems; and integrated safety management systems.

6.2 FACILITIES AND PROCESSES PROPOSED FOR THE LLNL OPTION

6.2.1 Facility Descriptions

The LLNL plan for fabricating MOX fuel for the LA project primarily uses two existing, adjacent facilities within the LLNL Superblock security complex. Receipt, storage, and processing of powder and fabrication of pellets and rods would take place in the currently operating LLNL PF-I3, Building 332. PF-I3 is a section of the PF built in 1977 to support the LLNL nuclear test program. Installation of rods into bundles, storage of bundles, and preparation of bundles for shipment would occur in HETB, Building 334, located across the street from PF.

Other facilities at LLNL would be used in minor tasks. Nonnuclear rod hardware would be received and, if needed, processed in Building 335, located adjacent to Building 332. DUO_2 powder would be received and stored at an appropriate facility elsewhere at LLNL.

6.2.2 Process Descriptions

6.2.2.1 Powder receipt and storage

The PuO_2 powder would be received and confirming NDA measurements would be performed in PF, then the powder would be stored initially in one of the PF vaults until needed in the MOX fuel line. PF is limited to a plutonium inventory of 700 kg and has the capacity to receive the planned annual shipments. As an operating plutonium S&S Category I facility, PF has all MC&A systems to properly receive and document the receipt of the feed material.

DUO_2 powder would be received and stored in Building 335 until needed in the MOX fuel line. PF currently is limited to a uranium inventory of 300 kg. LLNL personnel plan to seek an increase in the allowable uranium inventory and believe they will be successful.

6.2.2.2 Powder, pellet, and rod fabrication

The MOX fuel line located in Room 1013 of PF-I3 would process PuO_2, DUO_2, and MOX powders; press and sinter pellets; and fabricate rods containing MOX pellets. Rods would be inspected, except for x-ray, in Room 1013 before being moved in protective packaging to HETB for x-ray and temporary storage.

LLNL plans to create a batch of 30% PuO_2 master blend by high-intensity blending of about 4 kg of PuO_2 and an appropriate amount of DUO_2. The batch would be sampled, tested, and reblended as needed to meet specifications.

Qualified master blend then would be combined with additional DUO_2 and appropriate additives to produce a batch of MOX powder designed to meet the reactor operator specifications for pellets. The MOX powder would be sampled, tested, and processed as needed to meet specifications. Test pellets would be produced and analyzed before processing the entire batch of material into pellets.

A sample of green pellets would be pressed, sintered, and analyzed before an entire batch of powder is pressed into green pellets. Green pellets would be visually checked before the batch is sintered.

Qualified pellets would be loaded into sintering boats and sintered in a horizontal pusher-type furnace. Following sintering, pellets would be centerless ground to final dimensions and receive dimensional and visual inspection. A sample of the batch of pellets would be submitted to metallographic and analytical examination to ensure that the batch conforms to all specifications.

Rejected powder and pellets would be either crushed and milled for MOX feed, prepared for disposal as waste, or held for transfer to the immobilization program.

Glove boxes for rod assembly also would be located in Room 1013. Rods would be loaded horizontally with pellets and springs, and the end caps would be welded, decontaminated, and helium leak checked. When the rods are clean and leak-tight, they would be inspected with gamma and neutron scanning equipment, inventoried, placed in a protective package, and moved to HETB.

LLNL plans to arrange all of the bulk powder and pellet processing equipment in Room 1013 in interconnected glove boxes to facilitate material transfer through the process without breaking containment or bag-in and bag-out operations except for removal of samples.

6.2.2.3 Interim storage of powder and pellets

Each PF room, including Room 1013, is limited to an inventory of 20 kg of plutonium. If the amount of in-process materials in Room 1013 approaches the 20-kg limit, some materials probably would be returned to one of the PF vaults or another PF processing room for temporary, in-process storage.

6.2.2.4 Interim storage of rods

Rods filled with MOX pellets would be stored in HETB, Room 1008, in racks or trays. Rods would be identified and entered into MC&A inventory.

6.2.2.5 Bundle assembly and inspection

Consortium-supplied fuel bundles partially filled with LEU fuel would be stored in HETB, Room 1008, until MOX rods are available. MOX rods would be installed horizontally. LLNL identified no postinsertion inspection, but the SET assumes LLNL would position the bundles upright and perform dimensional inspections as may be required by the consortium. HETB would be equipped with stands to permit bundles to be suspended vertically for inspection.

6.2.2.6 Bundle storage

Bundles would be stored on vertical storage racks in HETB, Room 1008, until shipment is required. HETB would have the facilities to package the bundles for shipment and load bundles onto SSTs or commercial vehicles, as required. LLNL has the necessary administrative systems to facilitate shipping.

6.2.2.7 Handling of consortium-supplied hardware

The site would receive and store consortium-supplied hardware until needed in the fabrication process. The consortium is expected to supply sufficient rod hardware to produce rods loaded with 3 MT of MOX fuel (approximately 1500 rods plus spares). The rod hardware would be received and, if needed, welded in Building 335, located adjacent to Building 332. The consortium is expected to supply fuel bundles partially filled with LEU rods and may choose to supply process equipment or tooling.

6.3 CHARACTERIZATION OF THE LLNL PF-I3 OPTION

6.3.1 Project-Level Attributes

6.3.1.1 Facility and mission compatibility

The areas in PF-I3 selected by LLNL for MOX fuel fabrication and the area in HETB selected by LLNL for bundle activities have no scheduled missions that would conflict with the proposed LA project. The PF and HETB buildings are part of a complex of buildings contained inside a security boundary known as the LLNL Superblock.

PF is an operational plutonium facility built to support DOE Defense Programs (DP) weapons research. PF-I3 currently is devoted to supporting DOE programs in developing plutonium-processing technology, developing improved safety features for plutonium pits, providing testing and surveillance studies of pits returned from stockpile, reducing LLNL excess fissile materials and storing LLNL plutonium and fissile uranium. Between 1999 and 2001, LLNL plans to operate a laboratory in PF to perform limited demonstrations of processes for immobilizing plutonium wastes in ceramic form for disposal in underground repositories. LLNL indicated that the immobilization laboratory would complement rather than conflict with the proposed fabrication of MOX fuel for the LA project. LLNL management has indicated that the LA project would complement the other Superblock missions and help defray facility costs. In the event of a national emergency involving the potential use of nuclear weapons, the Superblock defense mission potentially could impact the LA project; however, such an event also likely would cause reconsideration of the MD program strategy.

HETB was built to conduct mechanical tests on weapons components and continues to perform that mission.

6.3.1.2 Cost and cost risk

The reference cost estimate for the LLNL option for the LA project is $68M in constant FY 1998 dollars. The reference case contains data that incorporate comments by the site. After reviewing data from all the options, SET identified indeterminate factors that could cause the estimate to increase or decrease and used these factors with the reference case values to establish a cost range for the LLNL option. Figure 9 shows the ranges of estimated cost by project phase for the LLNL option. The adjustment factors are discussed below and summarized in Table 14. All costs are given in millions of unescalated FY 1998 dollars.

After studying the data provided by each site for burdened labor rates and other cost factors such as user fees, space charges, and program loads, SET adjusted the labor rates and various fees used in the project models for each option to provide the most direct cost comparison among the options possible. By applying this process, SET computed an adjustment for the LLNL option that increased the costs associated with space charges by $1.2M and increased the costs associated with labor rates by $13.4M.

A factor that could lower project cost would be the shortening of the preoperational phase of the project. SET estimated that the LLNL option could be shortened by as much as 9 months without incurring cost or quality penalties. Further, SET estimated cost savings of approximately $0.7M for the potential schedule improvement.

As discussed in Sect. 6.3.1.3, LLNL staff indicated that they might need to prepare a supplement to their existing EIS. This activity is not included in the reference case costs, and no cost adjustments have been made to the LA project estimate for this activity.

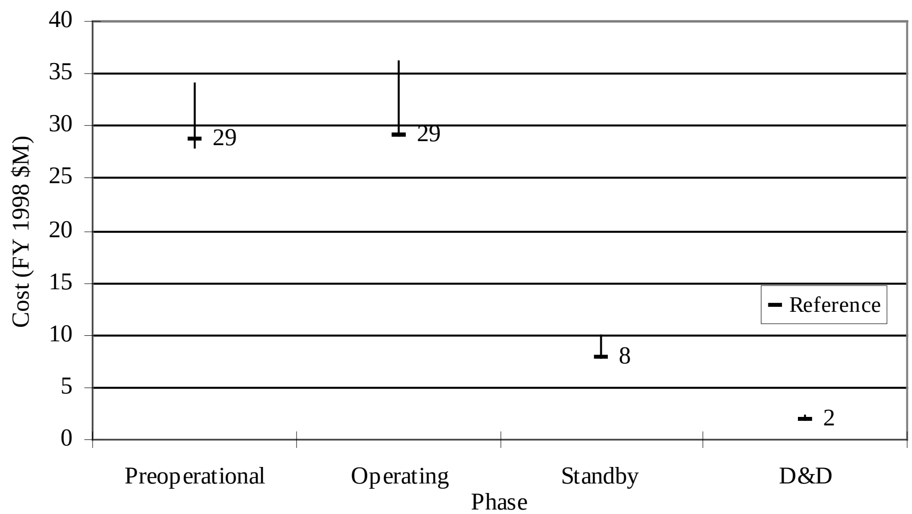

Fig. 9. Cost ranges by phase for the LLNL option.

Table 14. Cost adjustments for the LLNL option by project phase

Factor	Cost adjustment ($M)				
	Project total	Preoperational phase	Operational phase	Standby phase	D&D phase
Space charges	+1.2	+0.5	+0.5	+0.2	0.0
Labor rates	+13.4	+4.8	+6.5	+1.8	+0.3
Schedule reduction	-0.7	-0.7	0.0	0.0	0.0
EIS supplement	0.0	0.0	0.0	0.0	0.0

6.3.1.3 Schedule and schedule risk

The schedule developed by SET in collaboration with the LLNL team shows that this option can meet the June 2003 milestone for the fabrication of the first qualified MOX rod.

The LLNL option has the potential for beginning the production of qualified MOX fuel earlier than the June 2003 milestone. The proposed space is adequate in size and has few features that would constrain arranging the process steps to enable efficient material flow. As in other operational S&S Category I facilities, the modifications would have to be performed under tight security. Almost the entire MOX fuel fabrication process would be installed in a room, 40 ft by 80 ft, which currently contains partially completed process modules installed in the 1980s to support R&D in processing of plutonium using laser separation technology. The modules are not contaminated and should be easily removed and dispositioned. The design, demolition, and modifications to provide a suitable space are minimal. Time and effort could be saved by fabricating process modules, installing selected equipment items, and performing operational checks on integrated process modules in a clean off-site fabrication facility. Thus, the portion of the work that must be done under rigid Category I security can be minimized. Needed modifications to facilities are minimal. Existing operating analytical laboratories located nearby have suitable capabilities to supplement the analytical needs of the project. No schedule risk from interference with other missions has been identified. SET estimates that a schedule improvement of 9 months and related cost reduction of $0.7M are possible.

Permitting could constrain the schedule for an LLNL option. LLNL indicates that siting of the LA project there would require them to perform an additional site-specific NEPA analysis. LLNL personnel stated that a supplement to their 1992 EIS may be required and, if so, would take 18 months to complete and likely would begin in early calendar year 1998. Alternatively, an EA may be required and, if so, would take 9 to 12 months to complete. Also, LLNL personnel expect that their existing permitted processes for processing and storing various wastes for off-site disposal would be adequate for managing wastes from the MOX fuel fabrication process; otherwise, they would require a minimum of 2 or 3 years to acquire revised permits. LLNL and SET understand that these possible actions are not likely to delay the LLNL schedule.

6.3.1.4 Quality assurance program

LLNL has no recent, direct experience in fabricating reactor hardware to the NRC QA requirements contained in 10 CFR 50, Appendix B; however, with planned support from the consortium, LLNL should be able to meet the requirements. This attribute is important because the assemblies fabricated for irradiation testing during the LA project must meet consortium and NRC QA requirements.

6.3.2 Operational Attributes

6.3.2.1 Production-processing approach

The spaces proposed for this option have no significant physical or operational characteristics that would prevent the design and implementation of an efficient, productionlike process. The process is expected to meet requirements for equipment, overall batch size, and quality assurance. The LLNL team indicated that their process would be designed to accommodate the preferences of the consortium.

6.3.2.2 MOX fuel fabrication experience

LLNL has a few personnel with plutonium ceramic experience but no significant, direct experience producing MOX or other reactor fuel. LLNL is not known to have notable applicable manufacturing experience but has relevant plutonium-handling experience with its weapons research programs. LLNL appears to currently lack specific MOX fuel experience and relevant manufacturing experience that are needed to ensure effective support to the consortium in producing prototypical MOX fuel to NRC requirements. The staff should gain relevant experience if they proceed with plans to conduct R&D from 1999 to 2001 on plutonium ceramic processing to demonstrate the viability of immobilization of plutonium wastes. While the specifications for ceramic immobilization products are different from those of MOX fuel, the underlying processes require similar skills and technologies.

6.3.2.3 Existing prototypic process equipment

The site has no prototypic PPR or bundle assembly equipment. Prototypic analytical equipment exists, but additional equipment, such as an inductively coupled plasma mass spectrometer, high-temperature H_2 analyzer, leak detection equipment, and an ion chromatograph, is planned for installation either in existing analytical laboratories or within the Room 1013 processing area for prompt process control and product certification support.

6.3.2.4 Batch size flexibility and analytical optimization

The LLNL team proposed batches of MOX up to 100 kg in size. The consortium may prefer larger batches to ensure feed homogeneity and lessen analytical costs; however, 100-kg batches should be large enough to ensure acceptable product uniformity and avoid excessive analytical costs. Smaller MOX batches can be processed when needed for small campaigns.

6.3.2.5 Characteristics of proposed facilities for processing

LLNL has an operating plutonium facility, all the necessary physical and administrative infrastructure, and a cadre of trained plutonium workers. The spaces proposed for the MOX fuel fabrication processes and bundling processes are suitable, with minor modification, for the proposed processes. The large Room 1013 is relatively free of any features that could constrain the layout of glove boxes and equipment. Consequently, an efficient, productionlike material flow path can be established for making prototypic fuel. The proposed spaces are well located with respect to each other and to the supporting analytical laboratories, material vaults, and personnel amenities. Some arrangements would need to be made to satisfy the anticipated office work space for consortium staff.

6.3.3 Safety-Related Attributes

6.3.3.1 NEPA compliance

DOE MD is preparing a site-specific EIS for the Plutonium Disposition Program that is expected to permit the LA project to be conducted at any of the candidate sites without further NEPA actions. LLNL does not anticipate additional site-specific NEPA analysis beyond that which is to be included in the Surplus Plutonium Disposition EIS.

6.3.3.2 Safety bases

PF is a Hazard Category 2 nuclear facility. HETB is a Hazard Category 3 nuclear facility that would be upgraded to a Hazard Category 2 nuclear facility. PF has a DOE Order 5480.23-format SAR and TSRs that authorize plutonium and uranium processing. The proposed MOX activities probably would require only minor modification to the existing safety basis documentation. No problems are expected in updating the HETB SAR to allow the proposed bundle assembly and storage operations.

6.3.3.3 Operational readiness review

LLNL anticipates performing a self-assessment and a management ORR, as a minimum. They indicated that a formal DOE ORR in accordance DOE Order 425.1 also is likely before the introduction of plutonium to the MOX process line. LLNL has recent experience in performing ORRs.

6.3.3.4 DOE Order compliance

The proposed LA project will be regulated by DOE but led by the consortium. The consortium may be unfamiliar with DOE regulations and would expect the host site to ensure smooth, compliant operation. Furthermore, the project likely would be closely scrutinized by NRC and the regulatory offices of the consortium utility. The site would be responsible for ensuring regulatory compliance.

The Superblock staff has demonstrated rigorous compliance with DOE Orders in their operation of a facility that routinely handles kilogram quantities of plutonium.

6.3.3.5 Compliance with plutonium-processing and -handling facility design criteria

PF was designed and constructed and has been maintained in compliance with DOE PPHF requirements. The HETB was constructed to lesser requirements, but is sufficient for the planned activities. The staff and management demonstrate understanding of and compliance with PPHF criteria.

6.3.4 Safeguards and Security-Related Attributes

6.3.4.1 Physical protection

All processing activities would be within the Superblock PA. The bulk processing of PuO_2 and MOX powders and MOX pellets would be performed in Room 1013 of the existing MAA that encompasses PF. LLNL plans to reactivate the closed portal to PF-I3 to permit further separation of the LA project from classified activities that would be performed in other areas of PF. Some physical protection upgrades such as detection equipment, barriers, and cameras would be needed at the reactivated portal.

The bundle assembly would take place in the nearby HETB, an area that currently could store Category III quantities of SNM for short durations. Minor upgrades also would be needed in this area. Six additional security personnel would be added for access control, patrols, and SNM shipping and receiving surveillance.

6.3.4.2 Material control and accountability

Capability exists within the PA to provide necessary DA and NDA support for the MOX processing operations. A rod scanner would be added into the processing line. The preliminary MC&A plan that has been developed would be expanded, reviewed, and approved. Three or four additional personnel would be needed to support MC&A activities and support transfers of SNM.

6.3.4.3 Vulnerability assessment and site safeguards and security plans

A site VA exists for the entire Superblock PA. PF currently is a plutonium-processing facility and is protecting targets that are more attractive against the same likely threats. The bundle assembly activities proposed for the HETB, which also is within the Superblock PA, are not expected to significantly affect the existing VA. Also, the risk for SNM transport is not expected to be significant, but this needs further evaluation.

6.3.4.4 Radiological sabotage potential

This option has been assessed for RADSAB and PuO_2 dispersion potential. These analyses show that inventories of 20 kg of PuO_2 or 400 kg of MOX per room to be permissible.

6.3.4.5 Access by foreign nationals and uncleared personnel

All principal LA project activities would be performed in the Superblock PA, hence access by uncleared or foreign visitors to observe or participate in any part of the process would be strictly controlled. All bulk processing of SNM would be located in PF-I3, Room 1013, and bundle assembly in HETB, Room 1008. LLNL plans to have uncleared visitors and foreign nationals access the MOX processing area by using the PF-I3 entrance and locker room thereby isolating them from nuclear weapons activities being conducted in PF Increment 1. Additional protective measures may be required if other rooms in PF-I3 contain material or information that must be protected from access by visitors. Operations in the HETB also can involve classified materials, although the level of activity in HETB is low. Protective measures also would be required for HETB to ensure uncleared visitors do not have access to classified materials.

6.3.4.6 Special nuclear material storage

The PuO_2 would be received and stored in one of the PF vaults. The building currently is limited to an inventory of 700 kg of plutonium. Each room in the MAA, except for vaults, is limited to an inventory of 20 kg of plutonium. Existing vault storage is suitable to support the LA project. Only minimal rearrangement of vault contents would be needed to ensure efficient handling of materials and interfacing with the MOX fuel fabrication processes.

The PuO_2 would be moved as required to PF-I3, Room 1013, where it, along with the blended powders, pellets, and some rods, would be stored incidental to processing. The plutonium inventory limit of 20 kg per room is not expected to significantly constrain efficient MOX processing.

The rods would be moved to HETB, Room 1008, where they would be stored in protective racks until they are loaded into the bundles. The completed bundles also would be stored in this area.

6.3.4.7 Other safeguards and security characteristics

Other necessary S&S measures are in place to support the LA project. Ten additional personnel will require security clearances and enrollment in PASP.

6.3.5 Other Attributes

6.3.5.1 Site infrastructure available to support the LA project

Suitable site infrastructure for the LA project either is available to the proposed operating area or can be provided with minor administrative or equipment upgrades. These infrastructure items include S&S, MC&A, analytical laboratory capability, fire protection, medical, emergency response capability and control centers, water, sewer, electric power, and waste management.

6.3.5.2 Off-site transportation

The PuO_2 would be delivered by DOE SST vehicles and would be received at PF-I3. SSTs would be received and unloaded using the area adjacent to PF. The SSTs that must be left overnight can be parked unattended inside the Superblock perimeter. The facility routinely receives and ships material using SSTs, and no upgrades in equipment or procedures would be needed.

DUO_2 would be received and stored in Building 335 until needed in PF-I3.

The consortium is expected to supply bundles partially filled with LEU rods. LLNL would install MOX rods into designated positions in the bundles. These LEU-filled bundles would be stored in HETB until MOX rods are loaded and the fuel bundles are shipped to the reactor site. Bundles would be shipped from HETB via SST or, if appropriate, by commercial carrier.

Approved shipping containers and fixtures for safely moving rods from PF-I3 to HETB must be obtained.

6.3.5.3 On-site transportation

This option requires few on-site moves of radioactive material. PuO_2 would be received at PF-I3 and, ultimately, would be fabricated into MOX rods. The rods would be moved within the PA from PF-I3 to HETB for assembly into bundles. These buildings are adjacent within the Superblock PA and less than 50 m apart. These moves could be made using a number of transport means, including forklift, cart, or flatbed truck. The DUO_2 would be moved from Building 335 to PF-I3 as required for processing.

The only other on-site moves would be of radioactive waste.

6.3.5.4 Formal design methodology

LLNL has an established facility engineering function that is well-versed in DOE design criteria.

6.3.5.5 Waste management

LLNL has existing capability to manage and dispose of wastes that are expected to be adequate for the needs of the LA project. The site has the capability to process and certify TRU waste for future disposal in WIPP and currently handles and stores significant quantities of TRU waste on site. Solid LLW and mixed waste are handled routinely and stored for disposal off site. The infrastructure also exists for the handling and processing of liquid radioactive wastes. The impact of the LA project on waste operations at LLNL appears to be well within the scope of existing capabilities.

LLNL expects that the existing permitted processes for processing and storing various wastes for off-site disposal would be adequate for managing wastes from the MOX fuel fabrication process; otherwise, LLNL would require a minimum of 2 or 3 years to acquire revised permits.

6.3.5.6 Radiation protection

All sites have comparable ALARA goals for radiation workers. The ALARA goal at LLNL for a new mission is a group average of 500 mrem/year compared to the current goal of 750 mrem/year.

6.3.5.7 Decontamination and decommissioning

LLNL plans to remove the unneeded equipment, wipe down the interiors of glove boxes, dispose of the waste, and leave the glove boxes in place for use by future projects. LLNL has experience in the decontamination of glove boxes.

7. LOS ALAMOS NATIONAL LABORATORY

7.1 DESCRIPTION OF THE LANL SITE

LANL, operated by the University of California for DOE, is located approximately 35 miles from Santa Fe, New Mexico, on a mesa about 7000 ft above sea level. The site has been operational since the 1940s as a multiuse R&D laboratory for defense and other missions. The laboratory has processed large quantities of ^{238}Pu, ^{239}Pu, and ^{235}U as metals, carbides, oxides, and nitrides in a variety of forms in the execution of many of these missions. LANL recently manufactured ^{238}Pu heat source pellets in their PF-4 facility for the National Aeronautics and Space Administration. Currently, LANL has the technical lead for MOX fuel fabrication for the Fissile Materials Disposition Program, with an FY 1998 budget of more than $10M. One-half of this budget is spent performing R&D in the areas of feed qualification and supply, fuel fabrication process development, analytical methods development, and PuO_2 feed conditioning.

LANL has an extensive laboratorywide infrastructure to serve the needs of a growing scientific community. This existing infrastructure to support the LA project mission includes nuclear facilities with authorization bases and demonstrated safe operations, plutonium-processing and fuel fabrication equipment, a large cadre of trained and experienced plutonium operating personnel, a validated analytical chemistry and material characterization capability, a complete waste management system, and the necessary MC&A systems to process large quantities of SNM.

7.2 FACILITIES AND PROCESSES PROPOSED FOR THE LANL OPTION

7.2.1 Facility Descriptions

The LANL plan for fabricating MOX fuel for the LA project uses three existing facilities: (1) TA-55/PF-4 for powder processing, pellet fabrication, rod fabrication, and material characterization; (2) TA-50/37, the RAMROD facility, for rod NDE and bundle assembly and inspection; and (3) CMR for analytical chemistry support. Powder processing and pellet fabrication would take place in the currently operating fuel-fabrication laboratories in PF-4, Rooms 125, 126, and 128. Rod fabrication would be located in Room 201. Once the rods have been verified as leak-tight and contamination free, they would be transported in batch-size lots to the RAMROD facility for nuclear and nonnuclear NDE. They would then be transported back to the basement of PF-4 for storage in a secure cage. Just before bundle transportation off site, the appropriate rods would be transported back to the RAMROD facility where they would be assembled into a bundle. The bundle then would be inspected, loaded into a DOE-supplied shipping package, and immediately shipped off site or shipped back to PF-4 for longer-term storage.

7.2.2 Process Descriptions

7.2.2.1 Powder receipt and storage

The PF-4 vault would be the location for the receipt and inspection of PuO_2. The NDA measurements for receipt would be located in PF-4. If early analysis of feed materials is desired, samples can be taken in PF-4 and analyzed either in PF-4 or CMR.

The DUO_2 would be received and stored in PF-4.

7.2.2.2 Powder, pellet, and rod fabrication

As needed for the processing operations, the PuO_2 and DUO_2 powders would be moved to glove boxes in the PF-4 fuel-fabrication laboratories for blending operations. All powder processing and pellet production processes would be performed in Rooms 125, 126, and 128. Each glove box is permitted to contain up to 10 kg of PuO_2. A master blend of 30% MOX would be generated and qualified. Final blends of MOX powder (nominally 5% plutonium content) would be prepared by blending and further processing appropriate amounts of DUO_2 and master blend. Each powder batch would be sampled and temporarily stored until qualified for subsequent pellet processing. Powder would be pressed into pellets and sintered in a continuous-type furnace. Visually acceptable sintered pellets would be finished in a centerless grinder, then inspected for size and surface defects. Rejects would be stored as segregated scrap, and acceptable pellets would be segregated and stored for assignment to rods. Some amount of automation or mechanization is envisioned for handling-intensive tasks. Glove boxes would be connected through the overhead material transfer system.

The rod fabrication would be performed in Room 201 of PF-4. Certified pellets would be loaded into tubes and the tube ends closed by welding. The closure weld would be examined by NDE, and the rods would be checked for leaks and radioactive contamination. Acceptable rods would be stored temporarily in Room 201 and in the PF-4 basement storage cage.

Rods would be transferred from the PF-4 basement storage cage to RAMROD for rod inspection. Rods would be accumulated and campaigned through the rod inspection process. Inspected rods would be returned to the PF-4 basement storage cage until needed for insertion into a bundle.

7.2.2.3 Interim storage of powder and pellets

Because PF-4 operates like a vault, in-process storage of powder or pellets is permitted in glove boxes. In-process powder and pellets also may be returned to the PF-4 vault for temporary storage.

7.2.2.4 Interim storage of rods

Rods would be moved and stored on protective racks in the PF-4 basement storage cage.

7.2.2.5 Bundle assembly and inspection

The RAMROD facility is proposed for assembly of MOX rods into consortium-supplied bundles already partially filled with LEU rods. RAMROD would have fixtures and equipment for rod inspection, rod insertion, bundle inspection, and packaging bundles for shipment. The facility would have the capability for vertical positioning of the bundles for inspection. Adequate security at RAMROD would be accomplished by the presence of armed protective force members temporarily stationed in the operating area rather than by enhanced physical barriers or other means.

7.2.2.6 Bundle storage

There are no plans to upgrade RAMROD security to permit routine storage of bundles containing MOX. Consequently, bundles probably would be shipped immediately after rod loading and inspection or placed in protective shipping containers and returned to the storage cage in the basement of PF-4.

7.2.2.7 Handling of consortium-supplied hardware

The site would receive and store consortium-supplied hardware until needed in the fabrication process. The consortium is expected to supply (1) sufficient rod hardware to produce rods loaded with 3 MT of MOX fuel (approximately 1500 rods plus spares) and (2) fuel bundles partially filled with LEU rods. Also, the consortium may choose to supply process equipment or tooling.

7.3 CHARACTERIZATION OF THE LANL PF-4 OPTION

The PF-4 facility is an operational S&S Category I, safety Hazard Category 2, plutonium-processing facility that meets the current DOE standards for such facilities. The existing operational storage vault in PF-4 would be used for the storage of plutonium containing powders and pellets not in process. The operational fuel-fabrication laboratories (Rooms 125 and 126), with their existing glove boxes, would be used with minor modifications for the powder and pellet fabrication processes. These laboratories have large plutonium limits (10 kg) established for each glove box and must be operated in a manner similar to an SNM storage vault. Modifications proposed are limited to equipment upgrades to meet consortium-specific requirements and include purchasing and installing:

- a granulator in an existing glove box,
- production model blending and milling equipment in existing glove boxes, and
- a ceramic continuous-type commercial sintering furnace in place of existing glove boxes.

With the exception of the sintering furnace installation, each of the modifications first requires the removal of the associated piece of existing equipment (performed through removal of the glove box window). The sintering furnace installation would require the removal of two existing glove boxes, including D&D. Where appropriate for the new equipment, lines would need to be added.

The rod loading and welding activities would be performed in PF-4, Room 201. Only minor modifications would be needed for this process. Two contaminated and two uncontaminated glove boxes would be removed, and two new glove boxes would be installed. The appropriate loading and welding equipment would be installed, along with a certain amount of rod inspection capability (vendor defined) and rod storage racks.

The use of the existing glove box layout in the pellet fabrication area would limit the coupling of the process operations in an optimum configuration. Several “backtracking” material transfers between the process units would be required. This configuration may decrease the operating efficiency. The removal of large contaminated equipment items from gloves boxes and the modification of the existing contaminated gloves boxes inherently are high-risk operations that could result in contamination outside the containment envelope. The installation and checkout of equipment items would be significantly complicated in existing contaminated glove boxes that likely are not of the optimum design for the existing prototypic process equipment. Some of the rod inspection activities were moved to another facility, RAMROD, because of the limited space available in PF-4. The splitting of the rod inspection activities between facilities is not ideal because of the increased delay times for feedback to other process operations and increased on-site transportation requirements.

The rod inspection and bundle assembly activities would be performed in the RAMROD facility. Only minor structural and electrical service modifications are expected to be required for this facility. A functional, 5-ton crane services the area proposed for bundle assembly. The procurement and installation of rod storage racks, rod inspection equipment, bundle assembly devices, bundle inspection equipment, and bundle storage racks would be required. Bundle storage either would be in RAMROD on a restricted basis or in the basement of PF-4. Security upgrades necessary for storage of complete bundles in RAMROD would require additional security personnel, minor physical modifications, or both.

7.3.1 Project-Level Attributes

7.3.1.1 Facility and mission compatibility

The areas of Building TA-55/PF-4 selected for MOX fuel fabrication and the area in the RAMROD facility selected for bundle assembly have no scheduled missions that would conflict with the proposed LA project. TA-55 is a DOE DP facility for weapons material processing, and space is somewhat limited for the MOX fuel fabrication mission. In the event of a national emergency involving the potential use of nuclear weapons, the LA project might be impacted by the PF-4 defense mission; however, such an event also likely would cause reconsideration of the MD plutonium disposition program strategy. Defense facility reconfiguration actions that are consolidating activities such as pit production in TA-55 also could impact the LA MOX mission.

7.3.1.2 Cost and cost risk

The reference cost estimate for the LANL option for the LA project is $65.6M in constant FY 1998 dollars. The reference case contains data that incorporate comments by the site. After reviewing data from all the options, SET identified indeterminate factors that could cause the estimate to increase or decrease and used these factors with the reference case values to establish a cost range for the LANL option. Figure 10 shows the ranges of estimated cost by project phase for the LANL option. The adjustment factors are discussed below and summarized in Table 15. All costs are given in millions of unescalated FY 1998 dollars.

After studying the data provided by each site for burdened labor rates and other cost factors such as user fees, space charges, and program loads, SET adjusted the labor rates and various fees used in the project models for each option to provide the most direct cost comparison among the options possible. By applying this process, SET computed an adjustment for the LANL option that increased the costs associated with space charges by $0.5M and increased the costs associated with labor rates by $8.4M.

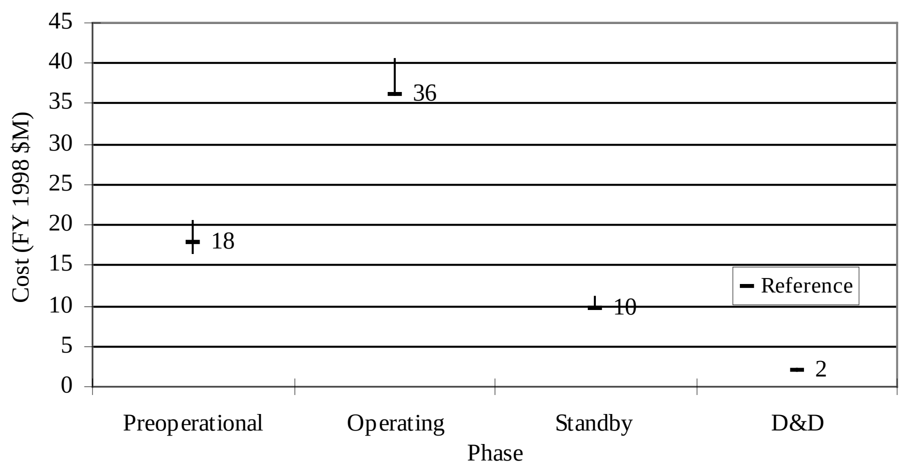

Fig. 10. Cost ranges by phase for the LANL option.

Table 15. Cost adjustments for the LANL option by project phase

Factor	Cost adjustment ($M)				
	Project total	Preoperational phase	Operational phase	Standby phase	D&D phase
Space charges	+0.5	+0.5	0.0	0.0	0.0
Labor rates	+8.4	+2.4	+4.4	+1.4	+0.2
Schedule reduction	-1.1	-1.1	0.0	0.0	0.0

A factor that could lower project cost would be the shortening of the preoperational phase of the project. SET estimated that the LANL option could be shortened by as much as 12 months without incurring cost or quality penalties. Further, SET estimated savings of approximately $1.1M for the potential schedule improvement.

Other factors that could result in lowered costs are potential synergies from having the development phase of the conversion process and MOX fuel process already in place in PF-4. The availability of researchers with insights into related processes could be a valuable asset if MOX fabrication problems occur.

Factors that could produce upward pressure on costs are potential difficulties in installing prototypic processes in the existing operating glove boxes or modification of these glove boxes to increase radiation shielding. If this occurs, a portion of the $5M credit included in the reference case for this option for using some existing glove boxes and equipment may be lost.

7.3.1.3 Schedule and schedule risk

The schedule developed by SET in collaboration with the LANL team shows that this option can meet the June 2003 milestone for the fabrication of the first qualified MOX rod.

The LANL option has the potential for beginning the production of qualified MOX fuel much earlier than the June 2003 milestone. LANL has a fully operational plutonium facility, the supporting infrastructure, and a cadre of trained plutonium workers. The LANL option apparently requires much less work to prepare for LA production than the other options; however, the challenge in cutting the schedule is to perform modifications under tight security in an operating plutonium contamination zone and in glove boxes within the PF-4 facility. Also, the existing glove box configuration may limit the flexibility for the consortium in making an optimum arrangement of the process.

The design, demolition, and modifications to provide a suitable space are minimal. Time and effort could be saved by fabricating the new glove boxes, installing selected equipment items, and performing operational checks on integrated process modules in a clean off-site fabrication facility. Thus, the portion of the work that must be done under rigid Category I security can be minimized. Needed modifications to facilities are minimal. Existing operating analytical laboratories located at the CMR have suitable capabilities to supplement the analytical needs of the project. No schedule risk from interference with other missions has been identified. SET estimates that a schedule improvement of 12 months and related cost reduction of $1.1M are possible.

7.3.1.4 Quality assurance program

LANL has no recent, direct experience of producing reactor hardware under the control of NRC QA requirements contained in 10 CFR 50, Appendix B; however, with planned support from the consortium, they should be able to meet the requirements. This attribute is important because the assemblies fabricated for irradiation testing during the LA project must meet consortium and NRC QA requirements.

7.3.2 Operational Attributes

7.3.2.1 Production-processing approach

The spaces that are proposed for this option and the associated glove boxes are modular box lines with a central transfer system ideally suited for discrete, laboratory-type operations. However, if the selected consortium wishes to establish a productionlike material flow for the LA project, these excellent laboratory facilities with their separate glove-box lines may be difficult to adapt. Whether the existing layout is overconstraining would depend on the preferences of the consortium. Regardless, a relatively efficient pilot-scale process that meets all expectations for equipment, batch size, and QA should be able to be placed into operation in the proposed space.

7.3.2.2 MOX fuel fabrication experience

LANL has extensive development experience with plutonium ceramic fuels (e.g., carbides and oxides) including MOX fuel for FFTF. Also, LANL recently produced pilot-production quantities of UN fuel for the SP-100 reactor program. The UN fuel was fabricated to reactor vendor quality standards. In addition, LANL recently produced limited quantities of MOX fuel for Canadian Deuterium Uranium Reactor and Advanced Test Reactor irradiation tests in support of the DOE MD program.

7.3.2.3 Existing prototypic process equipment

The existing PF-4 process contains some prototypic equipment (e.g., pellet presses and a centerless grinder), usable glove boxes, and the required analytical capabilities. Additional processing and analytical equipment would be installed to provide capabilities that are adequately prototypic of planned production equipment.

7.3.2.4 Batch size flexibility and analytical optimization

Plans for this option call for MOX batches up to 100 kg in size, but the LANL glove box inventory limit of 10 kg plutonium would permit batches of up to 200 kg without cross-blending. The consortium may prefer larger batches to ensure feed homogeneity; however, 100-kg batches should be large enough to ensure acceptable product uniformity and avoid excessive analytical costs. Smaller MOX batches can be processed when needed for small campaigns.

7.3.2.5 Characteristics of proposed facilities for processing

LANL proposes the use of space within an operating plutonium laboratory and the use of several existing glove boxes and some process equipment. The existing glove box lines have a central transfer system that has the potential advantage of lower radiation exposures during material transfers between process steps, but it may result in some inefficiencies in material transfers and limit the optimum layout of the process flow. Modification of the existing contaminated glove boxes and installation of the prototypical powder-processing and -handling equipment in them might be difficult. Except for possible minor adjustments to service connections, no facility modifications are required to upgrade the process line. The infrastructure suitable for supporting the LA process is in place.

7.3.3 Safety-Related Attributes

7.3.3.1 NEPA compliance

MD is preparing a site-specific EIS that is intended to be sufficient for conducting the LA project at any of the candidate sites without further NEPA actions. There is some risk that unspecified process or facility changes might require additional action. It is anticipated that any site selected would need to prepare supporting documentation to ensure that the EIS includes bounding case scenarios for the site-specific process and design. Additional NEPA action, if required, could delay the LA project.

7.3.3.2 Safety bases

Both PF-4 and RAMROD are designated as Hazard Category 2 nuclear facilities. PF-4 has a DOE 5480.23-format SAR that would need only minor modification to accommodate the LA project activities. RAMROD would have a new DOE 5480.23-format SAR and TSRs for other activities (e.g., waste repackaging) that can be modified to accommodate the MOX rod inspection and bundle assembly activities.

7.3.3.3 Operational readiness review

Readiness reviews have previously been performed at TA-55 for work similar to that proposed for the LA project. Consequently, the LANL staff anticipate that only a readiness assessment would be required. Experienced staff are available to conduct the readiness assessment or reviews.

7.3.3.4 DOE Order compliance

The proposed LA project will be regulated by DOE but led by the consortium. The consortium may be unfamiliar with DOE regulations and would expect the host site to ensure smooth, compliant operation. Furthermore, the project likely would be closely scrutinized by NRC and the regulatory offices of the consortium utility. The site would be responsible for ensuring regulatory compliance.

The TA-55 staff have demonstrated rigorous compliance with DOE Orders in their operation of a facility that routinely handles kilogram quantities of plutonium.

7.3.3.5 Compliance with plutonium-processing and -handling facility design criteria

PF-4 was designed and constructed and has been maintained in compliance with DOE PPHF requirements. The RAMROD facility was constructed to lesser requirements, but LANL plans to establish a sufficient safety basis for its use for bundle assembly and rod testing. The staff and management demonstrate understanding of and compliance with PPHF criteria.

7.3.4 Safeguards and Security-Related Attributes

7.3.4.1 Physical protection

Bulk processing activities would take place in PF-4, an existing S&S Category I processing area inside a vaultlike MAA. Movement of personnel and material into and out of the MAA is highly restricted. Separate personnel (ground floor) and material (basement) portals exist. No S&S upgrades, except for increasing the size of the basement storage caged area in PF-4, are needed.

The bundle assembly operation would take place in RAMROD, a building currently located within a PPA. RAMROD is located approximately one-quarter mile from PF-4 and is secured by PPA-type fencing and few other protective measures. The building has several large roll-up doors and other types of doors. Some minor upgrades such as access control, cameras, and physical barriers would be needed to secure this building. During bundle assembly and NDE operations, the primary protection would be from existing protective forces and restricted access. SNM would be present in the RAMROD building only during NDE and bundle assembly operations. At other times, rods and bundles would be moved back into the basement cage in PF-4 for storage. No additional security personnel have been added, although the plan calls for existing security personnel to be present at RAMROD anytime SNM is present.

Existing S&S systems and components are already part of a performance assurance program. Some new S&S components or systems are planned to support the new LA project, especially in RAMROD. All systems would have to be tested and evaluated. An evaluation of the VA assumptions would be required. Also, a force-on-force evaluation would need to be conducted for RAMROD.

7.3.4.2 Material control and accountability

The site is currently producing MOX test fuel within a plutonium operations area. An MC&A support plan exists for the test fuel fabrication, and this plan would need to be reviewed and updated for the proposed LA project. The process accountability flow diagrams already exist for the current MOX activities along with necessary material accountability measurements. Multiple MBAs are within PF-4. The MOX operations probably would be included in one of the existing MBAs. The rod filling, vault and basement cage storage, and RAMROD probably would be in separate MBAs. For the existing MOX operations, administrative records are maintained of the quantity of material in each glove box. The MBA custodians are separate from the operations personnel. Procedures used for current MOX operations would be used for the LA project. The existing PF-4 MC&A plans and procedures would need to be evaluated. Minimal effort is expected for these reviews. No additional personnel are proposed to support the MC&A activities.

Capability exists either at this location or the CMR to support all DA or NDA requirements. Additional DA/NDA capability is being planned for PF-4. Most NDA capability exists within PF-4 to support the MOX mission except for the rod scanner, which would be procured. The plan is that bulk and NDA measurements would be the basis for control for powder and pellets, then item accountability would be used after the rods are sealed.

7.3.4.3 Vulnerability assessment and site safeguards and security plans

PF-4 is a plutonium-processing area and currently is engaged in the fabrication of MOX test fuel. A preliminary assessment and identification of S&S upgrades have been done based on existing operations and the changes in the proposed operations. A site VA exists for the entire PF-4 area. The site is currently protecting targets that are more attractive against the same likely threats. The proposed LA project is not expected to significantly impact this facility VA.

A VA will not be required for RAMROD if the amount of SNM material never exceeds an S&S Category III quantity. However, a radiological sabotage analysis and a security plan would be required for RAMROD.

7.3.4.4 Radiological sabotage potential

This option has been assessed for RADSAB and PuO_2 dispersion potential. These analyses show glove box inventories of 10 kg of PuO_2 or 200 kg of MOX to be permissible.

7.3.4.5 Access by foreign nationals and uncleared personnel

Most of the PuO_2 and MOX processing operations would occur within the PF-4 MAA. This MAA also is expected to contain very sensitive, classified material that would need to be protected from the view by an uncleared person. Access by foreign nationals or uncleared personnel to the bulk processing and rod filling areas would be subject to strict visitor controls that are currently in effect.

Rod inspections and bundle assembly operations would be in the RAMROD PPA. When the rods or bundles are present in RAMROD, it would become a temporary LA. Uncleared visitor access can be arranged with relative ease.

7.3.4.6 Special nuclear material storage

The PF-4 vault would be used to receive and store any PuO_2 until it is needed in the MOX process line. No upgrades are needed for this vault. All bulk PuO_2 and MOX processing operations are contained within the vaultlike confines of PF-4. Because the entire PF-4 area is operated as a vault, some of the PuO_2 and various blends of MOX powder and pellets would be stored in the process glove boxes. Also, some in-process materials probably would be returned to the PF-4 vault for storage. The DUO_2 probably would be stored in the basement cage or an adjacent area. The rods would be filled and then stored in a caged area. The location for the long-term storage of the bundles and rods is in the basement cage of PF-4. The cages are currently being used as interim storage for SNM moving into and out of PF-4. Two-person control is needed to access the cages. Some rods may be stored temporarily in PF-4, Room 201. Rods, or bundles, or both could be stored in RAMROD if security of the facility were enhanced beyond the level planned by LANL. The cages in PF-4 probably would need to be enlarged to accommodate the LA project.

The LANL plan is to move batches of rods to RAMROD for final inspection and then return them immediately to PF-4 cages for storage. Later, selected rods would be returned to RAMROD for assembly into bundles. Completed bundles would be shipped directly from RAMROD or returned to the PF-4 basement cage for storage. The PF-4 cage area probably cannot accommodate the preferred vertical storage of bundles.

7.3.4.7 Other safeguards and security characteristics

All other necessary S&S programs are in place. All personnel currently working in PF-4 have a Q clearance and are under PSAP. The escort procedures for foreign and uncleared visitors have been recently updated and are in place. It is envisioned that any additional personnel who are needed for this mission can be obtained from existing cleared personnel. The personnel may need to come under the PSAP program, and for some, clearances may need to be upgraded. It is likely that foreign or uncleared visitors would need to be present almost continuously during the setup of the equipment and qualification of the MOX fuel fabrication process. The consortium may wish to have representatives present throughout the period of fuel fabrication. Consequently, the visitor access and escort procedures should be reviewed to look for ways to make this easier. The plan is to use MOX operations or technical personnel as escorts for visitors. No additional security clearances for escorts were included in the baseline estimate.

7.3.5 Other Attributes

7.3.5.1 Site infrastructure available to support the LA project

Suitable site infrastructure for the LA project either is available to the proposed operating area or can be provided with minor administrative or equipment upgrades. These infrastructure items include S&S, MC&A, analytical laboratory capability, fire protection, medical services, emergency response capability and control centers, water, sewer, electric power, and waste management.

7.3.5.2 Off-site transportation

The LANL option for the LA project requires no off-site transport of PuO_2 because the conversion of the weapon pits to PuO_2 also would be performed in PF-4. However, PF-4 has the capabilities to received and ship SNM via SSTs using the area adjacent to the basement cages. The SSTs that must be left overnight can be parked unattended in the TA-55 PA. The facility routinely receives and ships material using SSTs, and no upgrades in equipment or procedures would be needed. DUO_2 will be received and stored at PF-4.

The consortium is expected to supply bundles partially filled with LEU rods. LANL would install MOX rods into designated positions in the bundles. These LEU-filled bundles would be stored either in the PF-4 caged area or, if appropriate security is established, in the RAMROD facility.

Bundles may be shipped either from RAMROD or from the basement cage storage area in PF-4. If bundles are shipped directly from RAMROD, an existing truck loading area can be used, but some physical upgrades may be needed with necessary procedures established and reviewed. The MOX-LEU loaded bundles would be stored in an approved container and shipped using SSTs or other approved shipping means. Extra security forces would be present at RAMROD when bundles are assembled, packaged, and shipped.

Approved shipping containers must be obtained. The rods would be stored temporarily in the container inserts, which would also need to be obtained.

7.3.5.3 On-site transportation

Qualified processes exist at LANL for on-site transfers of SNM. All movement of bulk PuO_2 powder, MOX powders, and MOX pellets would take place within the MAA of PF-4. Except for waste materials and laboratory samples, all of the moves of SNM outside PF-4 would involve either rods or bundles moved between PF-4 and RAMROD. These buildings are no more than one-quarter mile apart, but the moves must cross the PF-4 MAA perimeter. Rods would be moved from PF-4 to RAMROD for NDE and promptly returned to the basement of PF-4 for storage in a secure cage. Just before preparing a bundle, the appropriate rods would be transported back to the RAMROD facility where they would be assembled into bundles.

Partially filled bundles of LEU supplied by the consortium would need to be moved from the PF-4 secure cage area or from storage locations in RAMROD for loading of MOX rods. Bundles containing MOX fuel that are not shipped immediately to the reactor site would be returned to the PF-4 secure cage area for storage.

LANL would perform all of the on-site moves. Approved containers would be needed for shipping and storage of rods and bundles. Although the capability for making on-site transfers of material currently exists, the procedures specific to the needs of the LA project would need to be prepared and qualified.

7.3.5.4 Formal design methodology

The LANL organization has an established facility engineering function that is well-versed in DOE design criteria.

7.3.5.5 Waste management

LANL has existing capability to manage and dispose of wastes that are expected to be adequate for the needs of the LA project. The site has the capability to process and certify TRU waste for future disposal in WIPP and currently handles and stores significant quantities of TRU waste on site. Solid LLW and mixed waste are handled routinely and either stored for disposal off site or disposed of on site. The infrastructure also exists for the handling and processing of liquid radioactive wastes. The impact of the LA project on waste operations at LANL appears to be well within the scope of existing capabilities.

7.3.5.6 Radiation protection

All sites have comparable ALARA goals for radiation workers. The ALARA goal at LANL for a new mission is a group average of 500 mrem/year compared to the current goal of 700 mrem/year.

7.3.5.7 Decontamination and decommissioning

This site proposed leaving most equipment items and glove boxes in place. LANL has experience in the decontamination and disposal of glove boxes.

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Appendix A
ASSUMPTIONS AND GUIDELINES FOR EVALUATING DOE SITES TO FABRICATE MOX FUEL LEAD ASSEMBLIES

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Appendix A. ASSUMPTIONS AND GUIDELINES FOR EVALUATING DOE SITES TO FABRICATE MOX FUEL LEAD ASSEMBLIES

A.1. DESCRIPTION OF THE PROCESS FOR DEVELOPING AND CHARACTERIZING CANDIDATE PLANS FOR FABRICATION OF MOX FUEL FOR LEAD ASSEMBLIES IN DOE FACILITIES

A.1.1 Background

The Department of Energy (DOE) Office of Fissile Materials Disposition (MD) expressed the desire to understand the capability of the DOE complex to manufacture limited amounts of mixed-oxide (MOX) fuel to fabricate lead assemblies (LAs) to burn in commercial reactors. DOE is considering irradiation of MOX fuel in existing commercial reactors as part of a hybrid approach, along with immobilization, for dispositioning surplus weapons plutonium. Consequently, DOE may wish to pursue a demonstration campaign of MOX fuel fabrication in the event that reactor owners consider LAs are required and it is determined that obtaining European-origin assemblies would be undesirable or untenable.

The LA program must be designed to qualify MOX fuel as a safe, reliable fuel for existing U.S. commercial reactors and demonstrate successful pursuit of the overall mission of dispositioning surplus U.S. weapons-usable plutonium.

MD requested Oak Ridge National Laboratory (ORNL), in its role as the technical lead for the reactor option, to organize and conduct an effort to identify and evaluate DOE sites which may be suitable for meeting MD's potential need for a domestic MOX fuel fabrication demonstration capability. MD also requested each DOE operations office to designate an individual to serve as a point of contact for providing information to ORNL for the respective sites that may be suitable for this mission. In response, each operations office designated an individual to represent its jurisdiction in this effort.

ORNL provided each site with preliminary screening criteria for identifying candidate facilities and requested each operations office representative to nominate candidate sites that he or she determined met the screening criteria and were willing to commit to the LA MOX fuel fabrication mission.

The operations office representatives nominated various DOE sites and facilities at Hanford, Idaho, Livermore, Los Alamos, Oak Ridge, and Savannah River as candidates for fabricating LA MOX fuel. The operations offices also identified an management and operating (M&O) contractor point-of-contact for each nominated site.

Subsequently, ORNL requested and received data from each site and prepared a LA data report for the surplus plutonium disposition environmental impact statement (EIS) for each of the nominated sites.

ORNL organized a team of specialists, hereafter referred to as the Site Evaluation Team (SET), to generate baseline assumptions and guidelines for characterizing and evaluating the plans of each candidate site. SET also will provide technical support to the site teams to develop the best plans for each site. After reviewing the information provided by the sites, SET will evaluate the site plans and characterize and document the strengths and weaknesses of each candidate plan.

A.1.2 Approach for Evaluating Candidate Facilities for Suitability

A three-step approach is being taken to characterize and evaluate the LA mission plans from each nominated site:

Step 1 SET generates baseline assumptions and guidelines for developing and characterizing candidate LA mission plans to satisfy the potential needs of MD.

Step 2 Each site team, in collaboration with SET, develops and documents the best plan(s) for using unique site and facility resources to meet the baseline assumptions and guidelines.

Step 3 SET reviews, characterizes, and documents the strengths and weaknesses of the sites' best plans.

A more detailed discussion of those steps follows.

First, SET has generated a list of baseline assumptions and guidelines for developing the plan that best uses the strengths of each site. The baseline assumptions address regulatory basis, process and specialized equipment for fuel fabrication, production schedule and quantities, relationships between the site personnel and the consortium to be selected for the reactor option of the program to disposition surplus weapons plutonium, and transportation and packaging processes. Early versions of these baseline assumptions and guidelines were presented as a basis for answering the EIS data call. Expanded guidelines are included in this document in Sects. A.3–A.6 and the appendixes.

Second, each site team continues the development of its approach to define the best use of facilities to fulfill the prospective LA MOX fuel fabrication campaign. The site teams are encouraged to call on SET to provide help in clarifying assumptions and guidelines, to provide baseline descriptions of features which would likely be common to the plans of all sites, and to aid the site teams in ways which may be useful and within the resources of SET. The site teams will be expected to document their best plan and host a site visit by SET to review the plan and candidate facilities. Following the site visit, each site team will be given the opportunity to submit additional information as may be appropriate to address issues or questions raised during the visit.

Finally, SET will collate and characterize the comparative strengths and weaknesses of each candidate plan. A draft document will be issued for comment. Following resolution of comments, the document will be issued.

Information about the Fissile Materials Disposition Program, Reactor Option, can be found on the Web Page: www.ornl.gov/etd/FMDP/fmdpproc.htm

A.2. GUIDANCE FOR DEVELOPING AND CHARACTERIZING CANDIDATE PLANS FOR THE FABRICATION OF MOX FUEL FOR LAS IN DOE FACILITIES

ORNL provided the designated representatives of the operations offices and respective M&O contractors with guidance for identification of candidate facilities. Three screening questions had to be answered affirmatively for a candidate to receive further consideration. The questions were as follows:

1. Is an operational Safeguards and Security (S&S) Category I facility capable of storing plutonium oxide (or master blend) and bundling and storing finished rods and assemblies (about 15-ft long) available on site?
2. Is an operating transuranic processing facility (which can operate as a S&S Category III or higher rated facility) available to house the MOX fuel pellet fabrication?
3. Is the site infrastructure for transuranic processing currently operating or in a standby condition such that it could be rapidly brought into service?

Detailed programmatic guidance developed by MD and extended by SET is contained in Attachment 1. From this guidance, SET constructed baseline process descriptions, assumptions, and cost estimating guidelines for developing and characterizing plans of the candidate sites. A discussion of baseline assumptions follows.

A.3. BASELINE ASSUMPTIONS

SET has developed additional baseline information and assumptions to aid the site teams in developing the best plans for using the resources unique to each candidate site to perform the LA fuel fabrication mission.

A.3.1 Regulatory Basis

DOE primary contractors and subcontractors are exempt from Section 53 of the Energy Reorganization Act of 1974 and 10 CFR 70 with regard to receiving title to, owning, acquiring, delivering, receiving, possessing, using, and transferring special nuclear material (SNM) in the use or operation of nuclear reactors or other nuclear devices in a U.S. government-owned vehicle or vessel as long as the Nuclear Regulatory Commission (NRC) determines that:

1. the exemption is authorized by law,
2. there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety, and
3. the DOE facilities and activities are not of the type subject to licensing pursuant to Section 202 of the Energy Act of 1974.

The LA MOX fuel fabrication facility will be a government-owned/contractor-operated nuclear facility. The facility will not be licensed by the NRC. This approach will place the burden of operational readiness verification and startup approval on DOE and its existing system of orders and directives which has been sufficient for a multitude of similar hazard type facilities.

The LA MOX fuel fabrication facility shall be designed in accordance with DOE directives, orders, and standards along with applicable national codes and standards. The methodology to develop the appropriate criteria list may vary based on site implementation of S/RIDS (DNFSB 90-2), the necessary and sufficient process (DOE M 450.3-1 currently is not mandatory), or an integrated safety management system (ISMS) approach utilizing work smart standards (DOE P 450.4 and G 450.4-1). DOE Order 420.1, *Facility Safety*, will also be applicable to the design and operation of the facility. The facility safety analysis report will be prepared in accordance with DOE Order 5480.23, *Nuclear Safety Analysis Reports*. Training for the facility personnel will be in accordance with DOE Order 5480.20, *Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities*. An operational readiness review will be performed per DOE-STD-3006-93, *Planning and Conduct of Operational Readiness Reviews*. Startup of the facility will be authorized in accordance with DOE Order 425.1, *Startup and Restart of Nuclear Facilities*. S&S shall be in compliance with DOE Order 5632.1C, *Protection and Control of Safeguards and Security Interests*, and Order 5633.3B, *Control and Accountability of Nuclear Materials*. Transportation and packaging for off-site shipments containing plutonium will comply with 10 CFR 71. The packagings will be shipped in safe secure trailers (SSTs) or approved commercial trucks. Fuel assembly packaging will meet reactor-receiving criteria. It is assumed that the LA MOX fuel fabrication activities will not be subject to International Atomic Energy Agency (IAEA) inspection.

A listing of directly applicable DOE directives and standards (although not all-inclusive) and other federal requirements is provided in Attachment 2. All other orders and directives applicable to each site must also be adhered to. Attachment 3 provides a listing of SNM attractiveness levels and quantities applicable for the LA MOX fuel fabrication facility.

In conjunction with this approach, it also will be necessary to establish interfaces between DOE and NRC to provide for NRC review of the fabrication quality assurance for the fuel intended for use in a NRC-licensed reactor.

A.3.2 LA Schedule Milestones and Production Window

The qualification of production MOX fuel will be the responsibility of the consortium that will determine LA needs. Based on these needs, DOE may choose to produce limited quantities of MOX at one of its sites to support the LA program while a commercial MOX plant is being designed, constructed, and licensed. The consortium is anticipated to be composed, as a minimum, of a commercial reactor owner and a MOX fuel fabricator. The program milestones for LA MOX fuel fabrication are given in Table A.1. The consortium is expected to be selected in September 1998. By January 1999, it is expected that DOE and the consortium will jointly select the DOE site for LA production from a list of qualified sites. At that point, LA fabrication facility design and equipment procurement can begin at the chosen DOE site.

The LA fabrication facility should produce the first qualified fuel rod by June 2003. The facility is to be sized to produce 1 metric ton (MT) of usable test fuel per year for 3 years. Thereafter for at least 4 additional years, the facility should be maintained in a state of readiness to produce extra fuel. Following the 3 years of production and 4 years of standby, the facility is released for other DOE program assignments or decontaminated and decommissioned (D&D), if required. Details of the production flow are discussed in Sect. A.3.4.

Table A.1. Lead assembly program milestones

Activity	Milestone date
Select site	January 1999
Produce first qualified rod of MOX fuel	June 2003
Produce LA fuel at 1 MT/year	June 2003–June 2006
Begin standby for possibly fabricating additional MOX fuel	June 2006
Release facility for other missions or D&D	June 2010–2013

A.3.3 Facility Operating Contractor Interface with MOX Consortium

The qualification of fuel, both LA and production, is the responsibility of the consortium. The proposed consortium will provide direct input and interface to the M&O contractor for the design and operation of the LA MOX fuel fabrication facility. The actual operation of the facility and design and modification of the facility will be the responsibility of the facility M&O contractor under contract to DOE. A close working arrangement allowing direct interface and input from the consortium staff will be necessary. The assumption is that the consortium team will require five on-site offices at the facility and that, because of uncleared foreign nationals on the consortium, an average of two escorts will be provided by the M&O contractor daily.

The LA MOX fuel fabrication line design input will be provided by the consortium team for incorporation into facility modification design prepared by the site facility (site architect-engineer or subcontractor). A design team will include representatives from the site, facility, and consortium. The site contractor representative shall ensure that applicable DOE orders are implemented in the MOX fuel fabrication design. DOE interface will be required during the design activities. The consortium team shall provide technical input and expertise for the MOX fuel fabrication. The consortium team will be provided necessary site information subject to security access restrictions. Other facility upgrades to accomplish compliance with DOE orders to support the MOX fabrication activity shall be the responsibility of the M&O contractor. Operational readiness verification and startup approval will require direct interface with the local DOE authority.

Construction activities shall be the responsibility of the M&O contractor. The consortium team may establish construction activity oversight but shall not have authority to implement construction modifications. Any changes shall be authorized by the M&O contractor. The consortium team shall have the ability to identify issues or request modifications via the M&O contractor. Direct interface will not occur between the consortium team and the construction contractor.

Facility startup, including operational readiness review, cold startup, hot startup, and other acceptance testing, shall be the responsibility of the M&O contractor. DOE approval will be required for each phase involving introduction of radioactive material. This phase will require a close interface with the consortium team. Field staff of the consortium would be expected within the facility and operating areas continuously. The consortium team would be providing direct assistance to facility staff during this phase. All hands-on work in the facility will be performed by the M&O contractor staff. The consortium staff will provide guidance, input to special tests and trouble-shooting support, but will not perform hands on work with the equipment or controls.

Facility operation after the startup period will be the responsibility of the operating contractor. The consortium will continue to provide a level of support sufficient to maintain continued operation of the fabrication line equipment and sufficient process control interface to produce pellets, rods, and assemblies that meet all acceptance criteria. An interface with NRC will also be required for verification of quality control of the completed fuel assemblies.

A.3.4 Process Description

Some key assumptions for the MOX processes are as follows:

1. A dry process will be used to fabricate MOX fuel; no liquids will be permitted in the fuel fabrication process line.
2. PuO_2 powder will meet specification as received.
3. DUO_2 powder will meet specification as received.
4. DUO_2 (no PuO_2) will be used to perform all systems shakedown (cold startup) tests.
5. The nominal factor for converting PuO_2 and DUO_2 to heavy metal (HM) is 88%.
6. All waste will be canned and sent to the plutonium immobilization program for final disposition.
7. All generated liquid wastes (e.g., laundry and mop water) are ancillary to the base process.
8. Sintering furnaces stay at temperature with a reducing atmosphere during the entire mission period of 3 years.

Process throughput assumptions and flow diagrams are shown in Attachment 4, Process Flow Diagrams. It needs to be understood that the required throughput is ~1.0 MTHM/year, but that a higher throughput capacity (~1.5 MTHM/year) should be established to accommodate process downtime and off-normal product rejection. The actual throughput capacity could vary because of site-specific conditions. The production throughputs are indicated for 3 years to accommodate irradiation and examination schedules. Also, the throughputs are in quantities of HM anticipated at the major process activities for the 3-year and 1-year time periods indicated, after the facility reaches steady state.

To achieve a state of reliable operations (i.e., qualified process and product), it is anticipated that a cold startup and a hot startup phase will be necessary. Attachment 4 provides the anticipated material requirements for each phase of startup and operations for the LA MOX fuel fabrication facility. Cold startup consists of using only DUO_2 in the fuel fabrication process to baseline each processing step. This phase of startup is anticipated to require 6 months or more.

Hot startup consists of using the final MOX fuel blend to qualify each processing step to acceptable standards of fuel quality and repeatability. This phase of startup is anticipated to require 6 months or more.

A.3.5 List of Process Equipment and Data Provided

Process equipment is defined based on the process flow diagrams and descriptions in Attachment 4. In Attachment 5, Matrices for Estimating Project Cost, the process equipment items are listed with estimated costs, dimensions, and overall space requirements. Procurement costs for the equipment items are expected to be similar among the sites and thus are not significant discriminators. Where applicable, the support equipment for facility functions is treated in the same manner as the process equipment.

The process flow diagrams in Attachment 4 include receipt of PuO_2, DUO_2 (and hardware), powder blending, pellet fabrication, rod fabrication, bundle assembly, and waste management, including estimated quantities of waste generated. Process equipment for these functions is identified in Attachment 5.

The waste flow diagram indicates how waste forms will be handled and dispositioned. The waste flow diagram provides a generic example of waste handling, and some sites may have specific variations. However, for purposes of this evaluation, cost estimates need to be as consistent with this flow diagram as possible. Waste processing equipment is identified in Attachment 5.

Included with the process flow diagram are the likely analytical measurement requirements for process control, accountability, and specified fuel requirements. The number of samples for estimating analytical costs is shown in Table A.2. A list of analytical equipment is provided in Attachment 5.

Table A.2. Analytical sample requirements

Material	Analysis	Number of samples per lot/batch (for estimating purposes)	Total number of samples
PuO_2,	Pu/PuO_2 assay	3	
number of lots ____	Pu isotopics	3	
(guidance is three lots)	Sieve analysis	3	
	Subsieve analysis	3	
	Surface area	3	
	Impurities	3	
	Moisture content	3	
UO_2,	U/UO_2 assay	3	
number of lots _____	U isotopics	3	
(guidance is one lot)	Sieve analysis	3	
	Subsieve analysis	3	
	Surface area	3	
	Impurities	3	
	Moisture content	3	
MOX master blend, number of batches ___	U:Pu ratio	3	
MOX final blend, number of batches ___	U:Pu ratio	3	
MOX pellets,	Pu, U/MOX	3	
number of batches ___	Pu, U isotopics	3	
	Ceramography	3	
	- Grain size, particle size		
	- Homogeneity		
	- Porosity		
	Moisture content; H_2	3	
	Volatiles	3	
	Impurities	3	
	O:M ratio	3 (samples/sintering day)	
	Miscellaneous impurities (e.g., Ga, Cl, F)	3	

A.3.6 Transportation and Packaging

This section discusses a number of areas regarding the packaging and transportation for the LA MOX fuel fabrication facility activities. The anticipated scenario is for PuO_2 powder to be shipped to the LA MOX fuel fabrication facility via DOE SSTs and for the MOX unirradiated fuel to be transported to the irradiation reactor site(s) by SST transport or approved commercial trucks. Local on-site transportation requirements will be met. The sites are responsible for complying with all applicable laws and regulations governing their operation under this task. A discussion concerning the transport, receipt of feed materials (e.g., PuO_2 and DUO_2), shipment of fresh MOX fuel assemblies, and on-site transportation follows.

A.3.6.1 Feed materials

The PuO_2 powder is to be moved by SSTs operated by the Transportation Safeguards Division of the DOE Albuquerque Operations Office. The PuO_2 will be shipped to the LA facility from various locations. During this transport, the PuO_2 will be under the protection of the SST and its escort. A secure unloading area must be available to receive and unload the SSTs. Also, in this unloading area, necessary material accountability measurements and procedures will be performed.

The transporting, receipt, and unpackaging of PuO_2 (and the packaging and shipment of the fresh MOX fuel) at the LA MOX fuel fabrication facility will require appropriate S&S measures. The sites must be able to provide necessary security for the SSTs while they are on-site. This would include necessary protective measures when the SSTs are loaded, as well as when the SSTs are empty. The SSTs are visually unclassified inside and out. However, certain features of the SSTs are classified. It will be necessary for DOE personnel to remain in control of the SST vehicle at all times. Appropriate controls, including Q clearances for all individuals who may have access to the SST information during loading and unloading, will be required.

Table A.3 provides information about the shipment of PuO_2. Table A.4 provides information about the shipment of depleted uranium oxide. Other materials provided by the consortium (e.g., new empty fuel rods, end plugs, grid spacers, and other assembly hardware) are not regulated materials from the standpoint of transportation. Their shipment would not require special packaging, other than to protect the economic value of the commodity.

The specific design of the LAs is uncertain. Some designs may involve having every fuel rod containing MOX, while other designs may involve inserting both MOX and UO_2 rods into a bundle. In the latter case, it could be necessary either to ship enriched UO_2 fuel rods to the MOX fabrication facility or to ship MOX fuel rods from the fabrication facility to a commercial reactor site to be assembled into bundles.

Table A.3. Transportation of PuO_2 to the LA MOX fuel fabrication facility

Number of shipments to the fuel fabrication site	1 or more
4.4 kg/package normally would be required. SSTs could accommodate 30–35 packages/trailer. A single SST convoy (3 trailers) could deliver the entire PuO_2 supply for the LA mission. To reduce facility inventory, the packages could be restricted to 0.9 kg or less. For 0.9-kg packages, 357 packages would be needed, requiring 4 convoys of 3 SSTs each.	
Container type used for shipment	Type B
Availability of containers	Yes
A likely candidate package would be 9968 or 9975, perhaps SAFKEG; only 9968 is currently certified	
Average shipping container weight, kg (lb)	165 kg (360 lb)
Average material weight loaded into container	4.4 to 4.5 kg
Average isotopic contents	Typical weapons-usable plutonium

A.3.6.2. Fresh MOX fuel assemblies

Like the PuO_2 fuel, the unirradiated MOX fuel will be shipped to the reactor(s) using SSTs or approved commercial trucks. Likewise, a secure loading area must be available and nuclear accountability measurements and procedures will be performed before the fuel leaves the site. It is envisioned that before fuel bundles are shipped from the LA MOX fuel fabrication facility sufficient nuclear material accountability measures will be performed so as to minimize such requirements at the reactor(s).

Table A.5 provides information about the transport of fresh (unirradiated) MOX fuel lead assemblies from the fabrication facility to the reactor sites. The same package identified for shipment of the MOX fuel assemblies (the MO-1) would also be used to ship groups of individual MOX fuel rods to a commercial reactor site for insertion into a MOX fuel bundle, should this approach be used.

Table A.4. Transportation of DUO_2 to the LA MOX fuel fabrication facility

Minimum number of shipments to the fuel fabrication site
  DUO_2 is shipped in standard metal drums
  Approximately 72 drums could be accommodated by a SST (40,000 lbs); the LA mission would require only about 20 drums of DUO_2
	1

Container types used for shipments
  This is a strong-tight container (open-head 55-gal drum)
  Will probably use UN1A2 (steel drum)
	208 L drum

Availability of containers	Yes
Average shipping container weight, kg (lb)	275 kg (600 lb)
Average material weight loaded into container	250 kg
Average isotopic contents	Depleted uranium

Table A.5. Transportation of LAs to reactor site(s)

Number of shipments to the reactor site Assuming that 4 or less assemblies are actually used for irradiation	2 or more

Container types used for shipments
  A likely candidate is the MO-1, USA/9060/B()
  A potential problem is that the NRC may require additional analysis to continue inclusion of the MOX contents on the package certification. Also, the MO-1 certificate lists 85% fissile Pu in total Pu. Additional analysis may be needed to ensure that the LAs can be transported in the MO-1.
  No package is currently available in the U.S. for boiling-water reactor (BWR) MOX assemblies. It is likely that the MO-1 certificate could be amended to allow 2 BWR assemblies.
	Type B

Availability of containers	Only two MO-1 packages exist
Average shipping container weight, kg (lb)	3900 kg (8600 lb)
Average material weight loaded into container	Approximately 1400 kg (3000 lb)
Average isotopic contents	N/A

A.3.6.3 On-site transportation

On-site transportation of PuO_2 MOX and unirradiated MOX fuel may be required and shall comply with the on-site transportation requirements of DOE Directive 460.1A. If public roads are used, then DOE Order 460.2 is also applicable. Certified packaging will be required. Site transport can be used, and it will be the responsibility of the site to provide necessary protection and to perform nuclear material accountancy and control. Sites should generally plan the same paperwork requirements as for off-site transport, although this area is being reviewed.

A.4. PROJECT COST ESTIMATES

This section provides outlines, format, bases, criteria, and questions to be answered and input required for the SET data call. The tables in Attachment 5 are provided to facilitate the LA fabrication site input and the SET review process. SET will establish process requirements and provide costs and other factors that should not be discriminators among the sites. This will normalize the data that are common among the sites and will provide an opportunity to readily evaluate the real differences. Suggestions from the sites to modify the common data to arrive at a more refined bottom line for the ultimate cost of fabricating LAs are welcome. However, by virtue of the SET charter, the final decisions and judgments will be the responsibility of SET, and the data will be normalized.

The tables in Attachment 5 list the functional requirements for the site facilities, processes, analytical chemistry, and other functions. Where data are considered to be common among the sites, the data are entered in the columns on the tables. The sites are requested to fill in the tables to provide a comprehensive data call. The process steps are basically provided in order of processing. The process steps and the data indicated are assumed to be as prototypic as possible of the consortium fuel fabricator. Obviously, adjustments will be made by the selected consortium fuel fabricator, but the process step functions identified here are not expected to be significantly changed and should not impact the ultimate SET site evaluations.

It is necessary to establish the batch-processing approach for each site and to estimate the cost of analyses (analytical chemistry) required to support the LA fabrication. Based on the throughputs identified in Attachment 4, the sites are requested to indicate the total number of lots and batches of PuO_2, DUO_2, and MOX powders planned in each site facility. The number of plutonium enrichments (concentrations) is assumed to be three. Based on the number of lots and batches required, the sites are requested to estimate the cost of analyses, in Attachment 5. Again, to normalize the data, the sampling plan for each batch is provided as a basis for meeting fuel quality requirements (see Table A.2). Also, as indicated earlier, the sites may suggest alternate sampling plans for refinement of the final evaluation, but the number of samples per lot or batch will be normalized.

The tables in Attachment 5 are organized as follows:

1. facility construction estimates,
2. process equipment estimates,
3. analytical equipment estimates,
4. permits and authorizations,
5. postconstruction startup,
6. other nonannual costs,
7. staffing (personnel, salaries),
8. other annual costs, and
9. project summary.

These cost categories are displayed in Attachment 5 in spreadsheet form. The sites will be provided a Microsoft® Excel spreadsheet file containing the tables in Attachment 5. The sites are requested to complete this electronic version and return it as a part of their response. The cost categories are or will be linked electronically to provide transfer and summation of costs. A major category of cost is one-time or fixed costs for construction, process and analytical equipment, permits and authorizations, postconstruction costs, and nonrecurring or nonannual costs. The remaining costs are annual operating costs. The total fixed and annual costs are provided by the spreadsheets.

Specific instructions for completing the cost matrices are provided in Attachment 5. A unique aspect of the matrices is that SET has assigned costs for equipment that is assumed not to be a discriminator in the SET evaluation. In this regard, if the equipment is existing ("y" response), the procurement cost is $0 unless ancillary equipment is being procured. If the response is "n," the assigned (estimated) cost is to be applied in the procurement cost column.

In a similar manner, functional minimum space requirements are indicated in the matrices (Attachment 5). Obviously, as with the assigned costs, these values are estimates and are not completely known but provide guidance to ensure the functions are adequately covered and as normalized as possible among the sites.

A.5. FORMAT AND CONTENT FOR SITE PLANS

Sites are requested to supply information that outlines their plan for satisfying the potential LA MOX fuel fabrication needs. Sites proposing both a Category I approach and a non-Category I approach are expected to provide a separate plan for each approach. To facilitate consistency in the reviews, the plans must follow the outline given in Attachment 6. If sites wish to submit additional materials, they may construct a separate document for that purpose.

The outline provides for discussion of identified variance from the baseline established in Sect. A.3, providing opportunity for a site to explain and justify variances, which may affect cost or schedule.

A.6. SITE/FACILITY QUESTIONNAIRE

The response to the Site/Facility Questionnaire (Attachment 7) is an important part of the site plan. Each site plan must include comprehensive answers to each question in the questionnaire. This structured approach is designed to avoid unnecessary efforts either by the sites or SET while providing the sites with the option of enhancing explanations if they wish.

Attachment 1
TECHNICAL AND PROGRAMMATIC GUIDANCE

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Attachment 1. TECHNICAL AND PROGRAMMATIC GUIDANCE

This appendix provides a basis for reviewing sites and facilities to determine their suitability to meet potential MD needs for a domestic mixed-oxide (MOX) fuel fabrication demonstration. In this appendix, the term "sites" refers to national laboratories and other DOE sites. The term "facilities" refers to buildings or structures and the equipment contained within them. In all cases, "facilities" are located on "sites." The terms "Category I" and "Category III" refer to safeguards and security requirements in accordance with DOE Order 5633.3B.

TECHNICAL REQUIREMENTS AND CONSTRAINTS

1. Existing Facilities and Infrastructure

Candidate sites must have an existing facility that is presently available and suitable for transuranic processing. Suitability means that the infrastructure is presently available on site to support plutonium handling and processing, including being designed for external events and the applicable safety classification. Note that the functions that are required need not necessarily be located in the same facility but all functions must be accommodated on the candidate site.[1]

The infrastructural requirements include the following functional specifications:

1. analytical laboratories for transuranic material;
2. waste management capability, including transuranic waste capability;
3. physical security for special nuclear material;
4. transuranic material handling, packaging, and storage;
5. staffing and human resources, including training for transuranic processing and possessing the appropriate security clearances;
6. storage and handling of chemicals (including but not limited to solvents, binders, lubricants, hydrogen, nitrogen, argon, and other industrial gases) and utilities;
7. civil support (e.g., sewers, potable water, roads, and fire protection);
8. special nuclear material control and accountability (MC&A);
9. environmental, safety, and health (ES&H);
10. radiation protection and criticality safety;
11. quality assurance;
12. transportation; and
13. all other required infrastructure support.

Specific site and facility requirements are identified in later paragraphs.

2. Permitting and Environmental Constraints

Candidate facilities must have or can reasonably acquire the proper environmental and other permits to enable MOX fuel fabrication. Existing National Environmental Policy Act (NEPA) coverage should exist or existing NEPA coverage should be easily expandable to accommodate the MOX fuel fabrication demonstration.

[1] A possible exception, as described in para. 4, is to have a master blend of mixed oxides prepared off-site and shipped to the candidate site, possibly in batch sizes sufficiently small to be used in non-Category I facilities. A Category I facility is not necessarily required for bundle assembly.

3. Site and Facility Structural and Processing Requirements

Candidate sites must be designed to receive PuO_2, DUO_2, and components for fuel assembly (cladding, assembly hardware, etc.).

The candidate site must have an active Category I storage facility that can handle plutonium powder in sealed cans and finished fuel assemblies (up to about 15-ft long).

A candidate site must have available an existing facility capable of being equipped to produce MOX fuel and perform all operations before preparing sealed and leak-checked fuel rods. The set of operations includes all processes where alpha containment is required. The facility must be rated for at least Category III as required by DOE Order 5633.3B.

A facility with a ceiling hook height of at least 20 ft must be available to handle complete fuel assemblies in a Category I area. The bundle dimensional inspection is to be performed with the bundle suspended vertically. These operations may be performed in the same area as the finished fuel storage, if desired.

4. Facility Access and Control

Facilities must meet DOE safeguards and security requirements, including DOE Orders 5632 and 5633.3B.

Ready access to fuel production operations must be made available to permit access by uncleared personnel, including foreign nationals. Ready access will be required to enable partnering between the selected consortium and DOE.

Two approaches should be examined for satisfying these two requirements:

a. Category I method

If the fuel production operations are conducted in Category I facilities, administrative procedures and/or hardware modifications must be effected to provide ready and frequent access by uncleared consortium personnel, possibly including foreign nationals.

b. Non-Category I method

If the fuel production operations can be performed in facilities rated for less than Category I, it may be possible to accommodate access by uncleared personnel, possibly including foreign nationals, without special administrative or hardware modifications.

Either method could prove satisfactory. The implementation of a particular method will be site-dependent. A prospective site may have options for both methods; *however, for the purposes of this assessment, no more than the leading candidate option for each method at each site will be considered. (The leading option for a particular method should be identified by the prospective host site.)*

5. Sizing and Fuel Supply Requirements

The pellet production operations must be able to support production of a statistically significant number of rods to enable rod testing in commercial reactors. The irradiations would be performed pursuant to fuel qualification and/or licensing. As a planning basis, the pellet production operations must be able to support insertion of MOX fuel rods into fuel assemblies in accordance with the following terms. Note that the terms here are meant to permit the non-Category I facility method. A Category I method should be able to support a higher throughput as the batch-size limitations for the non-Category I method would not apply.

The operations must be able to load the equivalent of approximately ten pressurized-water reactor (PWR) fuel bundles during a 3-year operating time. The basis for the ten bundles of PWR fuel, which is considered more limiting than the BWR bundle case, is that a four lead-assembly test program standard is frequently invoked for fuel irradiation programs in industry today. MD envisions that two fuel qualification campaigns may be required. The ten assemblies then provide a small margin over the amount required.

The number of MOX fuel rods in the assemblies needs to be sufficient to enable fuel performance to be assessed. Quantifying the fraction of rods that are MOX fuel rods is somewhat arbitrary. For planning purposes, assume that at least 1/3–1/2 of the rods need be to loaded with MOX fuel pellets. Assuming a rate of 100 g plutonium/rod, 200 rods/assembly at 5% in the MOX fuel, a peak-to-average throughput ratio of 1.5, the 1/3–1/2 range noted above, and a 25% downtime allowance for research and development activities yields a sizing of ~1.0 MTHM/year.

6. Schedule

The site shall begin to produce qualified rods of MOX fuel by June 2003.

The facility shall be capable of delivering the fuel assemblies during approximately 3 years (or less, if possible).

To permit additional MOX fuel fabrication that might be required, the facility housing the MOX fuel fabrication line shall be available for at least 4 years beyond the time required to supply the amount of fuel identified in para. 5. This requirement is imposed to ensure that MD has the option to extend the operation of the MOX fuel demonstration capability in the event that such a need should materialize. Release of the facility for other use or decontamination and decommissioning is planned following the 4-year standby period.

7. Operations

The MOX fuel fabrication demonstration capability must be able to mimic European fuel fabrication operations in the supply of feed materials and in the selection and operation of equipment, consistent with the scaled down size of the facility, relative to European operations.

The facility must be able to accommodate frequent access by the selected fuel fabricator. Note that the selected fuel fabricator will probably employ foreign nationals who will need access routinely to the facility. The fuel fabricator will provide technical guidance on operation of the facility and the selection of equipment, if the timing is practical.

The fuel fabricated must conform to the reactor owner’s fuel specifications. The fuel fabrication operations must provide fuel of the requisite quality to provide objective evidence for the fuel qualification program, both for qualification of the fuel design (a reactor owner performance requirement) as well as of the fuel fabrication process (a fuel fabricator performance requirement). The qualification basis would also include providing licensing-quality data.

The facility shall be operated in accordance with DOE Orders. For the purposes of the limited campaign, MD would not pursue any NRC licensing action for the facility.

The operations of the facility need to be planned as a research and development task since flexibility in production operations will be required. As an example of the research and development nature of the facility, multiple feeds will be provided to the facility as part of the mission of the facility.

The fuel operations shall be low-throughput glove box operations that do not warrant any significant degree of automation and robotics.

8. Materials

For the purpose of the limited fuel campaign, only weapons-usable plutonium with low americium content (0.5% or less as a fraction of the plutonium) shall be assumed to be made available to the prospective sites.

All hardware for assembly of fuel bundles will be procured from qualified suppliers, as identified by the consortium comprised of the selected utility, fuel vendor, and MOX fabricator.

The uranium for downblending, both the master blend (if applicable) and the final blend, shall be the uranium identified by the consortium.[2]

The site must be able to receive plutonium oxide powder in sealed cans after they are made available from the prototype pit disassembly operations at LANL. The site must also be able to receive the applicable amount of uranium oxide, presumably as depleted uranium.

9. Cost

MD desires to minimize the capital costs and the life-cycle commitments for the facility. This activity is perceived to be a limited life mission that is not a long-term financial commitment by DOE.

RELATIONSHIP TO SITING OF MD FACILITIES

It is intended that decisions pertaining to siting the mission fuel facility would not be impacted by the potential siting of a MOX fuel fabrication demonstration facility. The following guidance applies in relating a potential MOX fuel mission facility and a demonstration MOX fuel fabrication facility.

> The MOX mission fuel fabrication function has priority. The only existing facility being considered for the MOX fuel mission is the Fuels and Materials Examination Facility (FMEF) at the Hanford Site. The FMEF shall be considered for the LA fabrication capability if and only if the LA fabrication processes can be accomplished without interfering with other uses for the facility being considered in the EIS. Interference would include either occupying space directly or encumbering an area by presenting plutonium contamination that would hinder modification elsewhere in the FMEF.
>
> It is possible that other facilities are available at the Hanford Site for the demonstration mission. These other options can be explored, if any exist.

Similar to the previous discussion, consideration of siting the LA MOX fuel fabrication capability at the Fuels Processing Facility (FPF) at INEEL, which is being considered for pit disassembly operations in the ongoing EIS, must ensure that the LA MOX fabrication process does not interfere with the use of the FPF for the pit disassembly mission.

[2] It may be desirable to make a master blend off-site and ship the blend to the prospective site.

Attachment 2
REGULATORY BASIS

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Attachment 2. REGULATORY BASIS

A listing of directly applicable DOE directives (although not all-inclusive) for the MOX fuel lead assembly fabrication mission is provided in Table A.2.-1. All other orders and rules applicable to each site must also be adhered to.

Table A.2.-1. Applicable DOE Directives for MOX fuel lead assembly fabrication

Directive	Title
DOE Order 420.1	*Facility Safety*
DOE-STD-1020	*Natural Phenomenon Hazards Design and Evaluation Criteria for DOE Facilities*
DOE-STD-1021	*Natural Phenomenon Hazards Performance Categorization Guidelines for Structures, Systems, and Components*
DOE-STD-1022	*Natural Phenomenon Hazards Site Characterization Criteria*
DOE-STD-1023	*Natural Phenomenon Hazards Assessment Criteria*
DOE-STD-1024	*Guidelines for Use of Probabilistic Seismic Hazard Curves at DOE Sites*
DOE-STD-1027	*Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*
DOE-STD-3020	*Specifications for HEPA Filters Used by DOE Contractors*
DOE Order 5480.23	*Nuclear Safety Analysis Reports*
DOE-STD-3009	*Preparation Guide for U.S. DOE Nonreactor Nuclear Facility SARs*
DOE Order 5480.20A	*Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Nonreactor Nuclear Facilities*
DOE Order 5480.31	*Startup and Restart of Nuclear Facilities*
DOE-STD-3006	*Planning and Conduct of Operational Readiness Reviews(ORR)*
DOE Order 1240.2B	*Unclassified Visits by Foreign Nationals*
DOE Order 1360.2B	*Unclassified Computer Security Program*
DOE Order 3792.3	*Drug-Free Workplace*
DOE Order 5630.12A	*Safeguards and Security Inspection and Assessment Program*
DOE Order 5631.2C	*Personnel Security Program*
DOE Order 5632.1C	*Protection and Control of Safeguards and Security Interests*
DOE M 5632.1C	*Protection and Control of Safeguard and Security Interests*
DOE Order 5632.7A	*Protective Force Program*
DOE Order 5633.3B	*Control and Accountability of Nuclear Materials*
DOE G 5633.3B	*Control and Accountability of Nuclear Materials*
DOE M 5639.6A-1	*Classified Automated Information Systems*
DOE Order 5650.2B	*Identification of Classified Information*
DOE Order 5660.1B	*Management of Nuclear Materials*

Table A.2.-1. (cont.)

Directive	Title
DOE Order 6430.1A	*General Design Criteria*
DOE Order 151.1	*Comprehensive Emergency Management*
DOE Order 231.1	*Environment, Safety and Health Reporting*
DOE Order 232.1A	*Occurrence Reporting and Processing of Operations*
DOE Order 440.1-1	*DOE Explosives Safety Program*
DOE Order 460.1A	*Packaging and Transportation Safety*
DOE Order 460.2	*Departmental Materials Transportation and Packaging Management*
DOE Order 470.1	*Safeguards and Security Program*
DOE Order 471.1	*Unclassified Controlled Nuclear Information*
DOE Order 471.2A	*Information Security Program*
DOE Order 472.1B	*Personnel Security Activities*
10 CFR 71	*Packaging and Transportation of Radioactive Materials*

Attachment 3
NUCLEAR MATERIAL SAFEGUARDS CATEGORIES FOR MOX FUEL LEAD ASSEMBLY PROGRAM

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Table A.3.-1. Nuclear material safeguards categories for MOX fuel lead assembly program

Activity	Material form	Concentration (amount of Pu/item)	Attractiveness[a] level	SNM[b] category	Item/Material form[c] quantity limits
Receipt of plutonium oxide (PuO_2)	PuO_2 powder (in cans)	100% PuO_2 (~600 g Pu/can)	C	I II III	10 or more cans 4-9 cans 1-3 cans
Blend to master blend [(30% plutonium (Pu)]	PuO_2 powder (in bulk processes)	~30% Pu (N/A)	C	I II III	≥ 20 kg of master blend (MB) ≥ 6.67 < 20 kg of MB ≥ 1.33 < 6.67 kg of MB
Blend to final mix (5% Pu)	PuO_2 powder (in bulk processes)	~5% Pu (N/A)	D	II III	≥ 320 kgs of final mix (FM) ≥ 60 < 320 kg of FM
Pellet fabrication	Pellets (in bulk processes)	~5% Pu (~0.24 g Pu/pellet)	D	II III	≥ 66,666 pellets ≥ 12,500 < 66,666 pellets
Fuel rod loading and fabrication	Pellets (in bulk processes)	~5% Pu (~0.24 g Pu/pellet)	D	II III	≥ 66,666 pellets ≥ 12,500 < 66,666 pellets
Fuel rod loading and fabrication	Rods	~5% Pu (~100 g Pu/rod)	D	II III	≥ 160 rods ≥ 30 < 160 rods
Fuel bundle assembly	Rods	~5% Pu (~100 g Pu/rod)	D	II III	≥ 160 rods ≥ 30 < 160 rods
Fuel bundle assembly	Bundles	~5% Pu (~26.4 kg/bundle)	D	II	≥ 1 bundle
Shipment of bundles	Bundles	~5% Pu (~26.4 kg/bundle)	D	II	≥ 1 bundle
Special nuclear material (SNM) waste and other streams	Solid	Low-grade material	D E Waste	IV IV Waste	> 3 kg Pu > 1 g ≤ 3 kg Pu DOE waste criteria
SNM analytical laboratory	Solid	100% PuO_2, 5% & 30% Pu in MOX, other SNM, waste	C, D, E, Waste	II - IV	Category/Attractiveness depends on quantity and form of the sample
SNM storage	All forms	All concentrations	C D	I - IV II - IV	See below for SNM limits
Depleted uranium	All forms	All concentrations	E	IV	> 10 MT depleted uranium

[a]Attractiveness Level C	Attractiveness Level D
Category I ≥ 6 kg	Category I not applicable
Category II ≥ 2 < 6 kg	Category II ≥ 16 kg
Category III ≥ 0.4 < 2 kg	Category III ≥ 3 < 16 kg
Category IV < 0.4 kg	Category IV < 3 kg

[b]Based on Figure I-2 in DOE Order 5633.3B and the implementation guide for DOE Order 5633.3B (subject to concurrence from DOE/NN).

[c]The quantity limits are only for the specific activity indicated for that row and are based on the values indicated below and the amount of plutonium per item/material form.

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Attachment 4
PROCESS FLOW DIAGRAMS

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MOX Lead Assembly Fabrication Facility

Basic Fabrication Requirements for Lead Assemblies

		Product produced				Production required				8/15/97
	Units/bundle	Output - 3 years	Output - 1 year	Cold startup	Hot startup (6 mo.)	Rejection rate*	Capacity - 3 years	Capacity - 1 year	/day (200 day/year)	Total
Base requirements and assumptions										
Bundles/year (PWR 17 X 17) (number)		10	3			0%	10	3.3		10
Plutonium (Pu)-containing rods (number)	132	1,320	440	220	110	10%	1,452	484	2	1,782
Pellets (0.327 in diam. X 0.4 in. x 14 ft)	55,440	554,400	184,800	55,440	55,440	20%	665,280	221,760	1,109	776,160
Plutonium and depleted uranium required										
Plutonium [(5 % in DU - kg heavy metal (HM)]**	12.5	125	42		10	20%	150	50	0.3	160
Depleted uranium [(DU), kg HM]	250	2,500	833	225	208	20%	3,000	1,000	5	3,433
Total Pu + DU (kg HM)	263	2,625	875		219	20%	3,150	1,050	5	3,594
Scrap generation										
Total scrap DU (kg HM)				225						225
Total scrap Pu (mixed with DU - kg HM)					6		25	8	0.0	31
Total scrap DU (mixed with Pu - kg HM)					125		500	167	1	625
Recycle and recovery scrap and waste quantities										
Recycled hard scrap*** (mixed with DU - kg HM)					3.125		12.5	4		16
Recycled hard scrap DU (mixed with Pu - kg HM)					62.5		250	83		313
Scrap Pu to recovery (mixed with DU - kg HM)					3		10	3		13
Scrap DU to recovery (mixed with Pu - kg HM)					50		200	67		250
Waste Pu **** (mixed with DU - kg HM)					0.625		2.5	1		3
Waste DU (mixed with Pu - kg HM)					12.5		50	17		63
Waste volumes										
Volume of TRU waste generated (cubic meters)*****					5		60	20	0.1	65
Volume of LLW generated (cubic meters)				5	5		60	20	0.1	70
Volume of mixed LLW generated (cubic meters)				0.4	0.4		1.5	0.5		2.3
Volume of liquid LLW generated (liters)				20,000	20,000		240,000	80,000	400	280,000
Volume of liquid TRU generated (liters)					25		300	100	1	325
Volume of nonhazardous solid (cubic meters)				325	325		1,950	650		2,600
Volume of nonhazardous liquid (liters)				1,750,000	1,750,000		10,500,000	3,500,000		14,000,000

Pu - plutonium; DU - depleted uranium; HM - heavy metal

*Rejection rates are based on production output (i.e., 20% listed rejection rate is equal to a 16.67% base on production rate). Assumed that pellets in rejected rods can be reused.

**Three to five separate plutonium concentrations required in pellets; 5 % nominal to ~ 9 % maximum plutonium concentration in any pellet.

***Hard scrap is from centerless grinding of pellets and rejected sintered pellets; 50% of hard scrap is assumed to be recycled;
soft scrap consisting of off-spec powder blends, etc., will be recycled within process line and are not considered in this table.

****Plutonium contained in glove-box waste consisting of filters, gloves, wipes, discarded process hardware, etc. This value is based on 10% of scrap plutonium and is considered an upper bounding value.

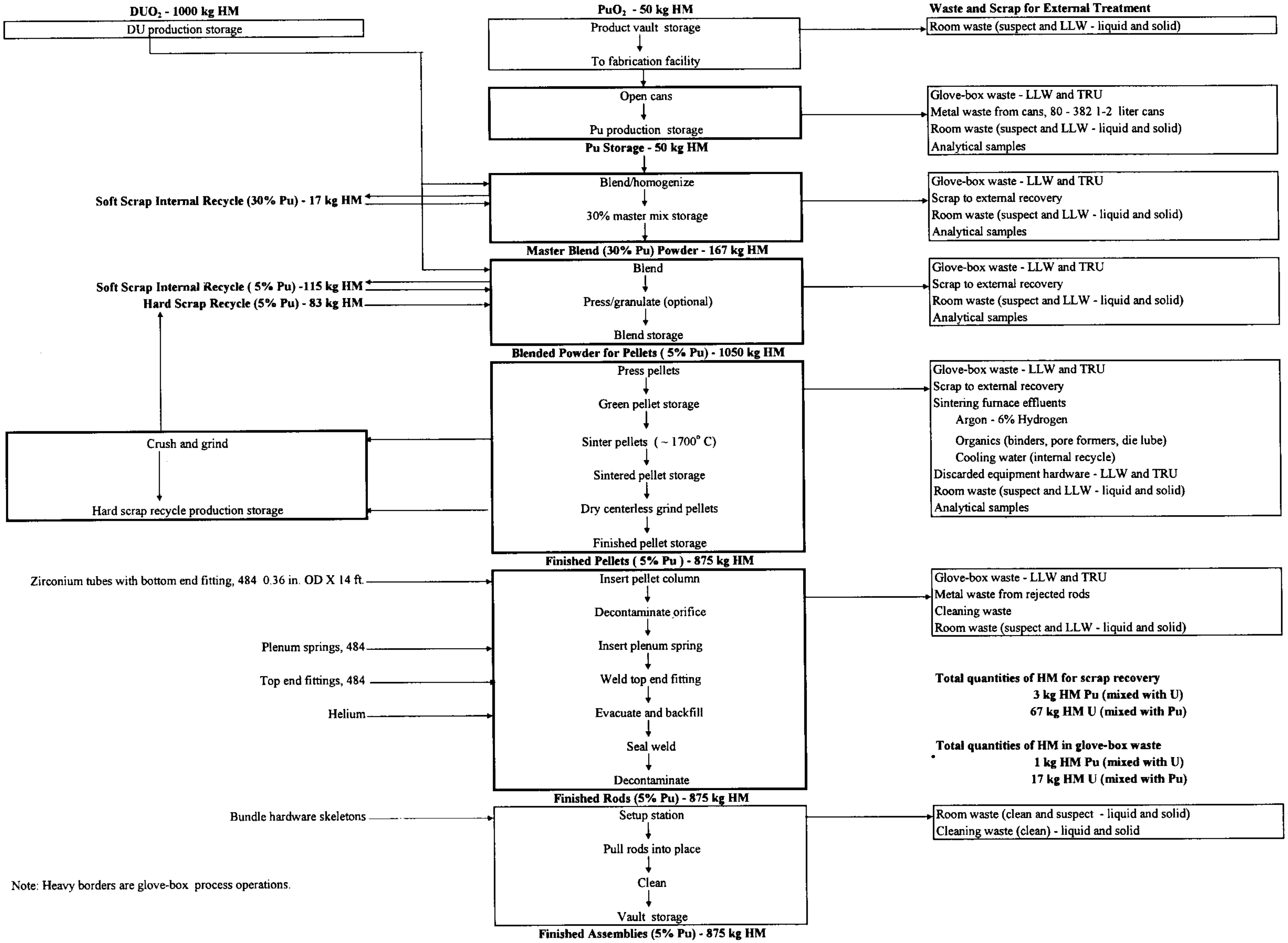
*****The volume of TRU waste includes mixed TRU waste. Solid waste volumes were estimated in number 200-liter drums generated.

MOX Lead Assembly Fabrication Facility

Process Outline with Yearly Throughputs (kg HM) and Major Scrap, Recycle, and Process Waste Streams

30% Master Blend Dry Process

8/19/97



Note: Heavy borders are glove-box process operations.

MOX Lead Assembly Fabrication Facility

Waste Types and Outline Flow Diagrams

8/15/97

Nonprocess Liquid Waste (aqueous)

Sanitary waste from all facilities → Sanitary sewer

Spent cooling water from facilities → Sanitary sewer

Sanitary sewer → Wastewater treatment plant

Nonprocess Solid Waste

Room trash, garbage, and similar solid waste → Send to landfill (on- or off-site)

Liquid Radioactive Waste

Liquid low-level radioactive waste (LLLW) → **go to LLLW Processing (1)**

Solid Radioactive Waste → **go to Solid Radioactive Waste Processing (2)**

Solid low-level radioactive waste (LLW) → **go to LLW Processing (3)**

Transuranic waste (TRU) > 100 nCi/g → **go to TRU Processing (4)**

TRU mixed with RCRA hazardous chemical waste (TRUMW) → **go to TRUMW Processing (5)**

LLW mixed with RCRA hazardous chemical waste (LLMW) → **go to LLMW Processing (6)**

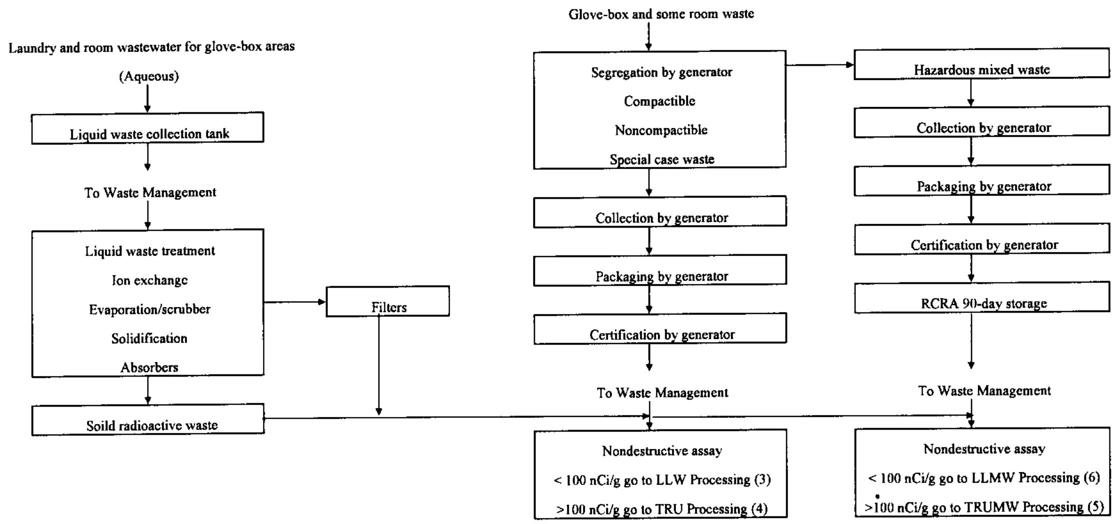
RCRA Hazardous Chemical Waste → Package and send to DOE or off-site RCRA treatment, storage and/or disposal facility (TSDF)

MOX Lead Assembly Fabrication Facility
Detail Waste Flow Diagrams

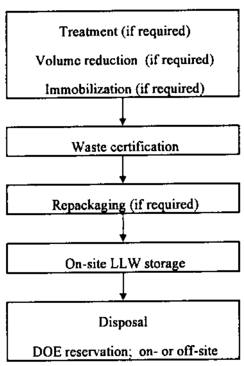
8/15/97

1. Liquid Low-Level Radioactive Waste (LLLW) Processing

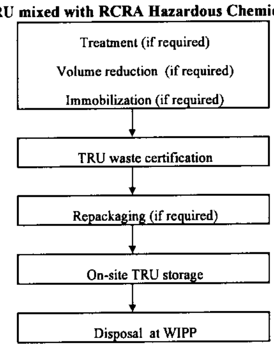
2. Solid Radioactive Waste Processing



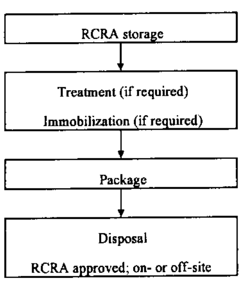
3. Solid Low-Level Radioactive Waste (LLW) Processing



4. Transuranic Solid Waste (TRU) > 100 nCi/g Processing and
5. TRU mixed with RCRA Hazardous Chemical Waste (TRUMW)



6. LLW Mixed with RCRA Hazardous Chemical Waste (LLMW)



MOX Lead Assembly Fabrication Facility
Estimated Volume of Waste Generated During Operation of Lead Assembly Fabrication Facility

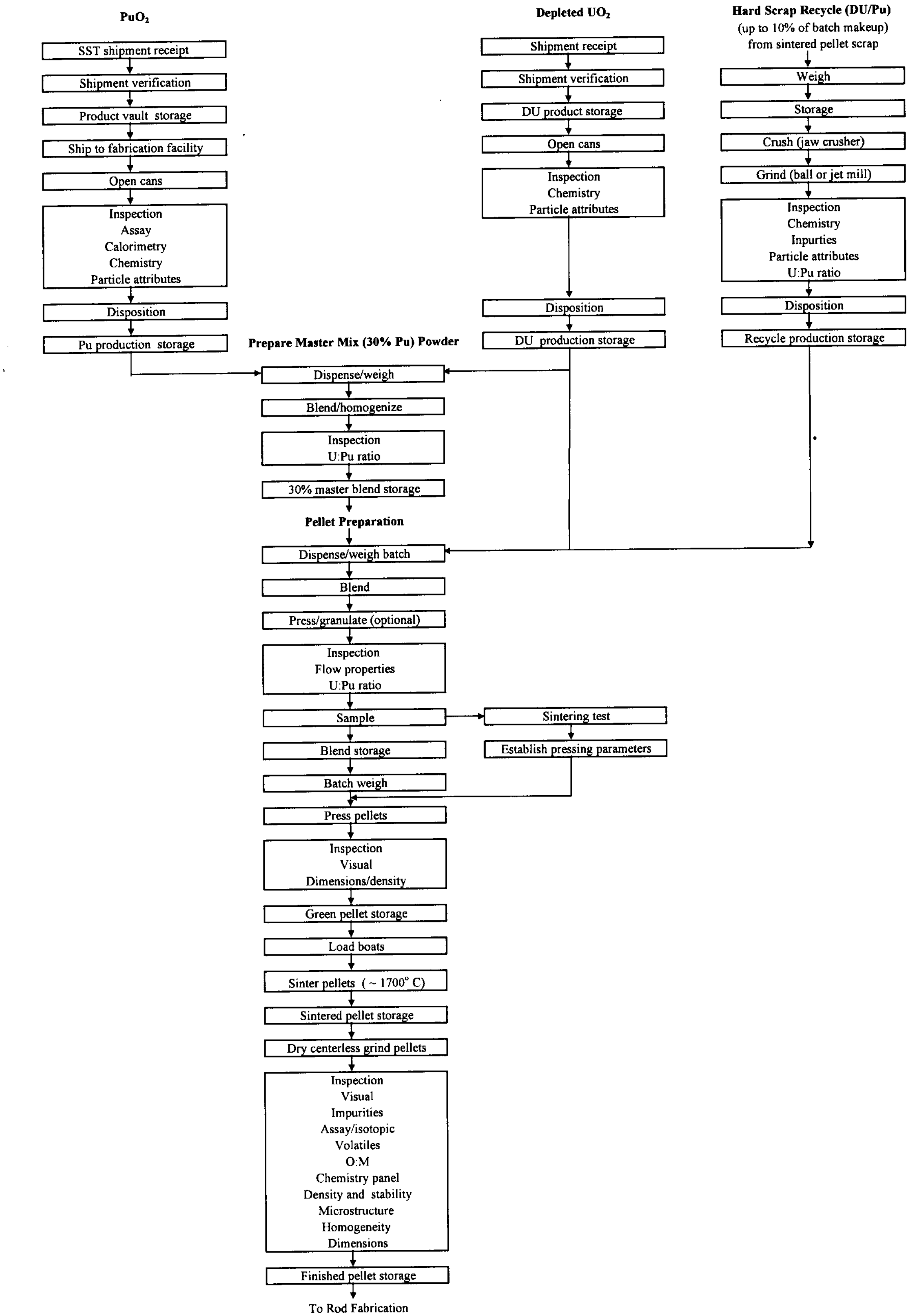
Waste category	Annual volume		Total volume		Waste description	Anticipated treatment	Disposal method
TRU, solid	20 m^3	706 ft^3	65 m^3	2295 ft^3	Glove-box gloves Bag-in plastic Empty bottles Filters Scrapped equipment items Furnace hardware Wipes Metal cans Metallography waste	Compaction	Off-site at WIPP
TRU, mixed* (included in TRU solid waste totals above)					Organics from sintering Sludges from liquids Analytical waste	From liquid treatment absorption to TRU solid	Off-site at WIPP
TRU, liquids	100 L	26 gal	325 L	85 gal	Sludges from liquids Analytical waste Metallography waste	Absorption to TRU solid or liquid LLW	As solid off-site at WIPP
LLW, solid	20 m^3	706 ft^3	70 m^3	2472 ft^3	Room trash Blotter paper Wipes Mop heads Gloves, shoe covers Solidified sludges Ion exchange resins Discarded contamination clothing Metal cans and rods	Incineration Compaction Solidification Metal melting	DOE on- or off-site disposal
LLW, mixed	0.5 L	0.1 gal	2 L	0.5 gal	Solvents from cleaning Analytical waste Sludges from liquids	Incineration Solidification	RCRA-approved disposal DOE on- or off-site Commercial off-site
LLW, liquid	280,000 L	73,968 gal	80,000 L	21,134 gal	Decontamination waste water Laundry waste water Analytical waste water	Ion exchange Evaporation/scrubber Solidification	Evaporation NPDES permitted discharge
Hazardous	0	0	0	0	None anticipated		
Nonhazardous, solid	650 m^3	22,955 ft^3	2600 m^3	91,819 ft^3	Office and lunch room trash Packaging materials Sewage sludges	Compaction Landfill	DOE on- or off-site landfill
Nonhazardous, liquid	3,500,000 L	924,595 gal	14,000,000 L	3,698,380 gal	Sewage waste	Sewage treatment	NPDES-permitted discharge

* Note: The volume of TRU mixed waste is a portion of TRU solid waste volume; mixed TRU waste is likely to come from sludges from wastewater treatment.

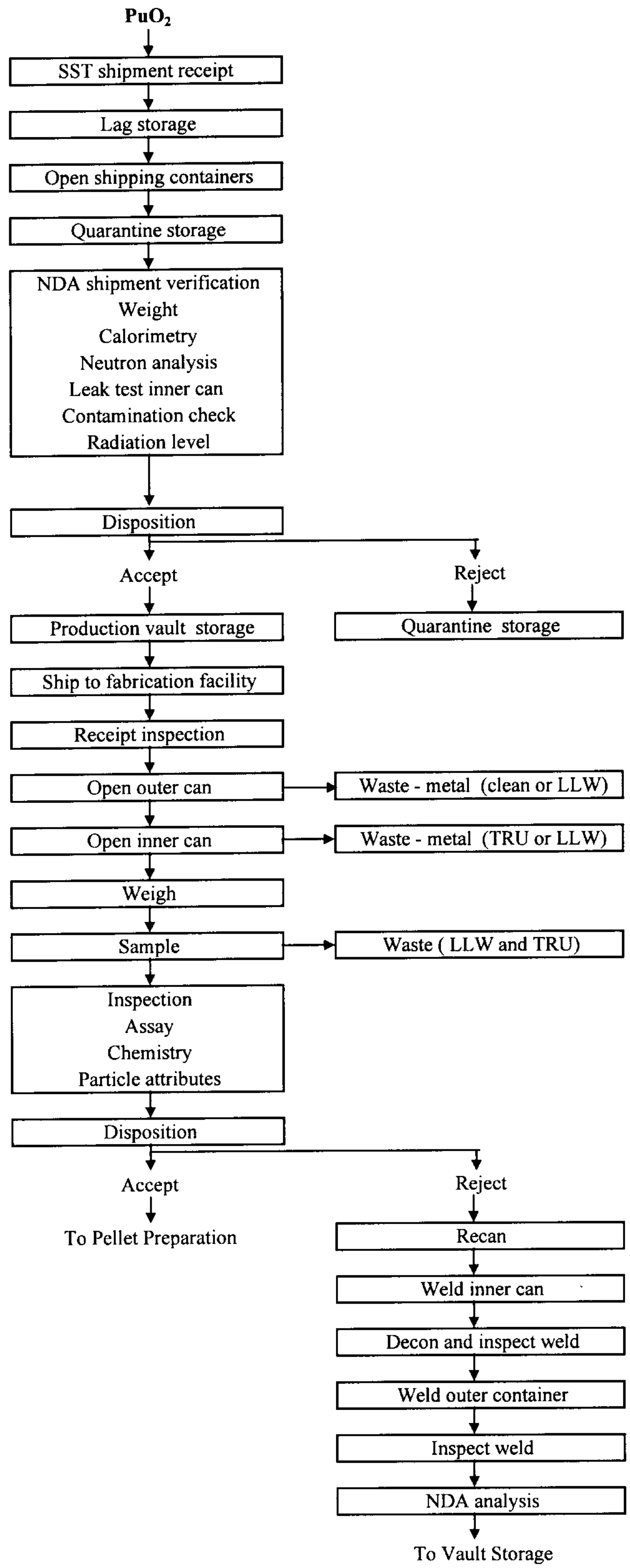
Base numbers were generated in SI units to 2 significant figures; English units are conversions. (Source: EIS data call.)

Solids are measured in m^3 or ft^3 and liquids in liters or gallons.

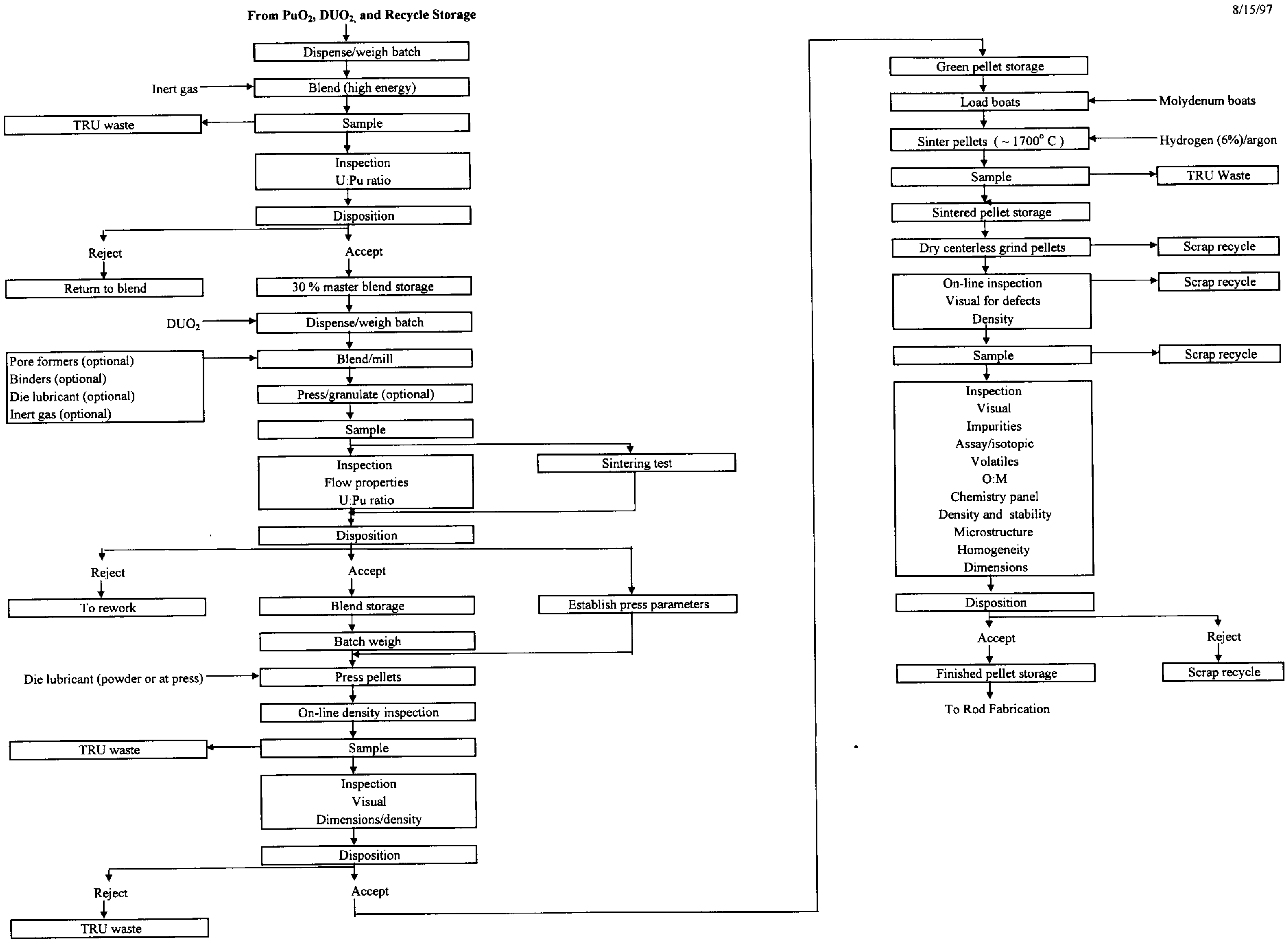
MOX Lead Assembly Fabrication Facility
MOX Pellet Outline Flowsheet Using 30% Master Blend Dry Process



MOX Lead Assembly Fabrication Facility
Detailed Flowsheet of PuO_2 Receipt and Storage

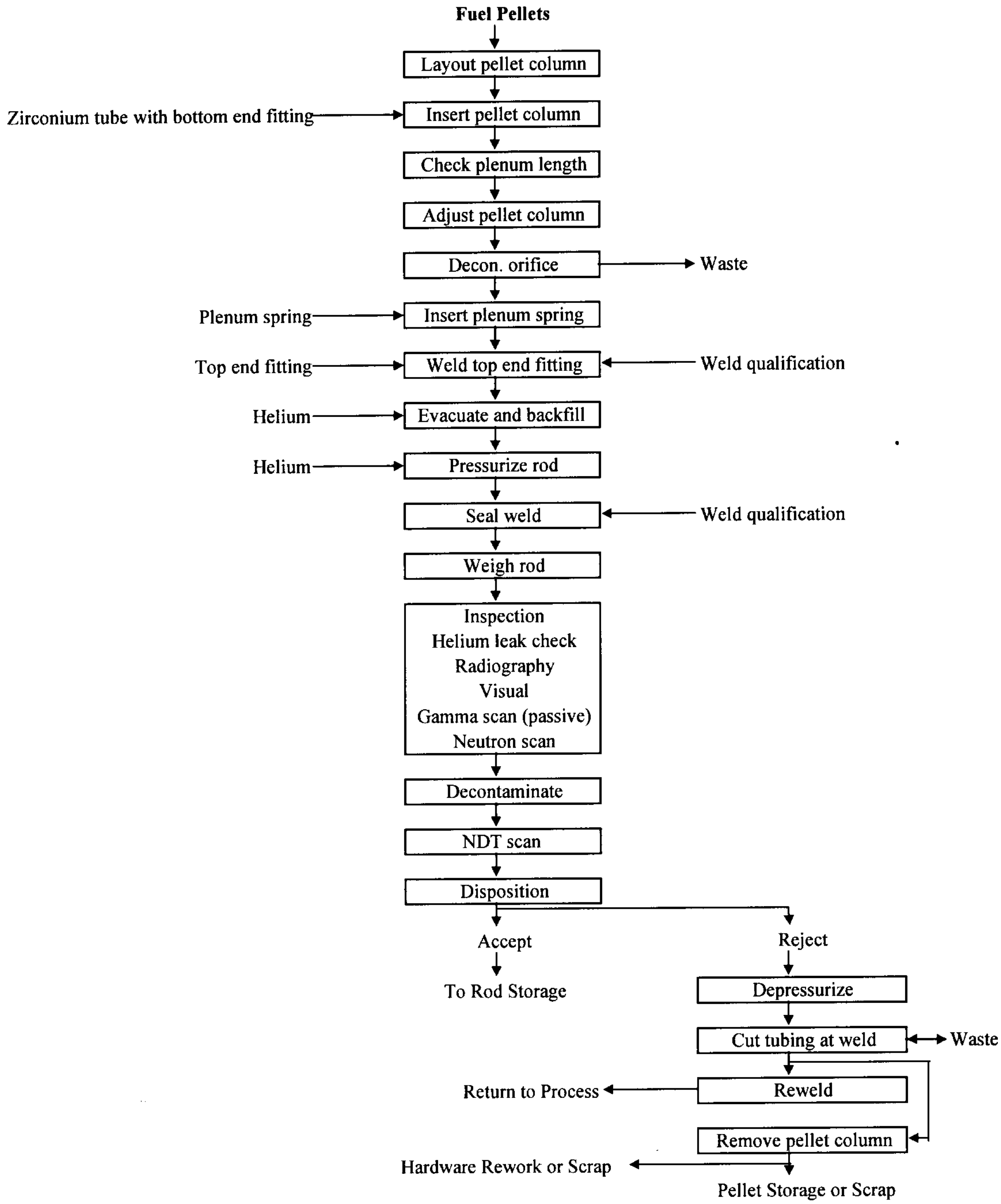


MOX Lead Assembly Fabrication Facility
Detailed Flowsheet of Pellet Preparation



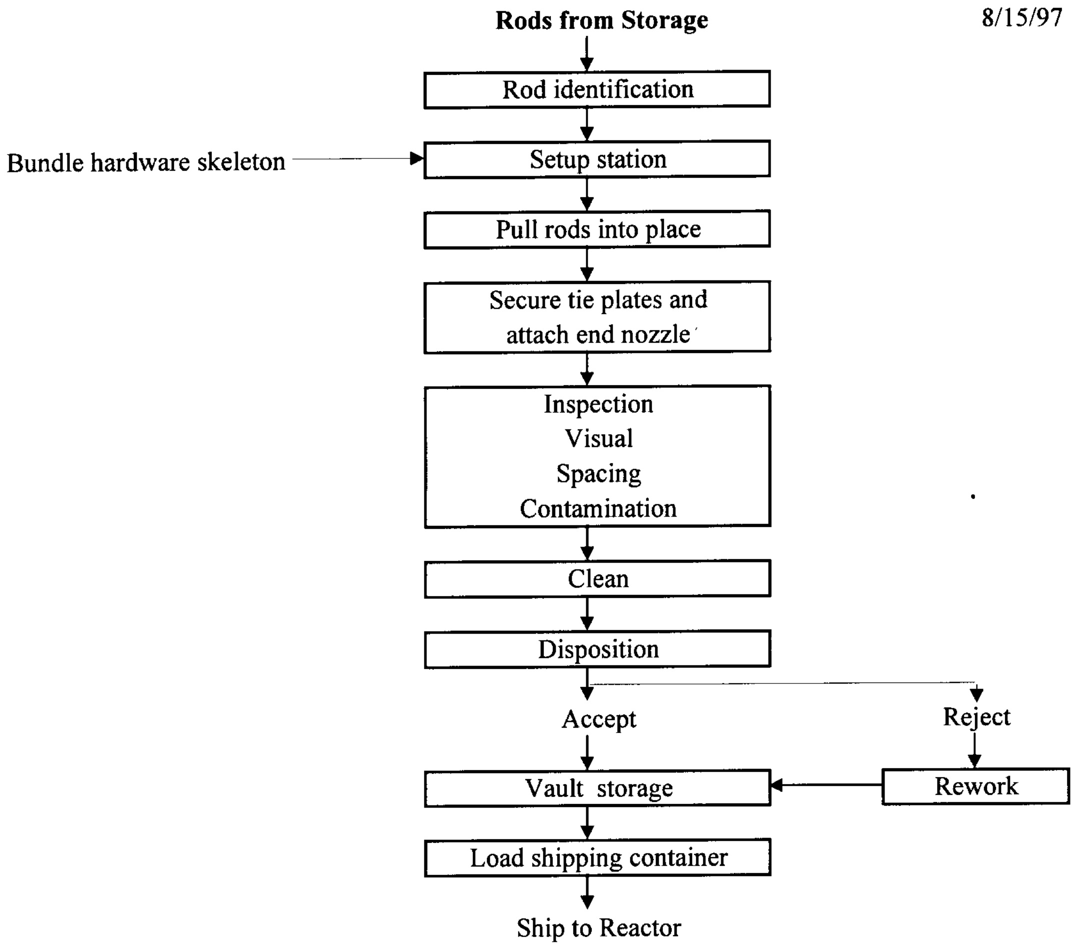
MOX Lead Assembly Fabrication Facility
Detailed Flowsheet for Rod Fabrication (PWR)

8/15/97



MOX Lead Assembly Fabrication Facility
Detailed Flowsheet for Bundle Assembly (PWR)

8/15/97



Likely Analysis in MOX Lead Assembly Pellet Fabrication Line for Process Control, Accountability, and Specified Fuel Requirements

8/11/97

Material	Analysis required	Typical analytical method	Typical accept value	Sampling frequency* per lot and batch	Sample size	Sampling method**	Comments
PuO_2 -powder lot***	Tap density	ASTM equal	~ 3 g/cc	Several cans in lot	NDT - 50 g	In-line grab	Simple and quick test - process control
	Subsieve analysis	Fisher subsieve	10–20 microns	Several cans in lot	NDT - 10–50g	In-line grab	May not be necessary with surface area
	Assay (Pu/PuO_2)	Wet chemistry	88% Pu	Several cans in lot	0.1 g	Grab	Needed for accountability and blend makeup
	Trace elements	ICP - emission spec./mass spec.		Several cans in lot	0.1 g	Grab	
	Isotopic	TIMS****/wet chemistry/ ICP mass spec.		Several cans in lot	0.1 g	Grab	Plutonium isotopic - needed for each lot
	Surface area	BET	~2 - m^2/g	Several cans in lot	1 g	Grab	
	Moisture content	Vacuum fusion, high temperature analysis	Weight loss at 100/450 C	Several cans in lot	1 g	Grab	Need both casual and chemical bound water
UO_2 -powder lot***	Tap density	ASTM	~ 3 g/cc	Several cans in lot	NDT - 100g	In-line grab	Simple and quick test - process control
	Subsieve analysis	Fisher subsieve	10–20 microns	Several cans in lot	NDT - 10–50g	Grab	May not be necessary with surface area
	Assay (U/UO_2)	Wet chemistry	~88% U	Several cans in lot	0.1 g	Grab	Needed for blend makeup
	Trace elements	ICP - emission spec./mass spec.		Several cans in lot	0.1 g	Grab	
	Isotopic	TIMS****/wet chemistry/ ICP mass spec.		Several cans in lot	0.1 g	Grab	Determine for each lot
	Surface area	BET	4–6 m^2/g	Several cans in lot	1 g	Grab	
	O:M ratio	Wet chemistry	2.05 to 2.1	Several cans in lot	1 g	Grab	Indicative of surface area, and the two must agree.
	Moisture content	Vacuum fusion, high temperature analysis		Several cans in lot	1 g	Grab	Need both casual and chemical bound water
	Sinterability	Press and sinter	97% theoretical density min.	3 pressures/3 temps.	12 pellets min.	Grab/pressed pellets	UO_2 will control sinterability of MOX pellets (95% UO_2)
30% master blend powder	Tap density	ASTM equal	~3–4 g/cc	~1–2 per batch	NDT - 50 g	In-line grab	Simple, quick test - process control
	Surface area	BET		2 samples - minimum	1 g	Splitter***	Need to determine something about milling operation
	HM assay/U:Pu ratio	Wet chemistry/ICP mass spec.	~ 88% HM/ 30% Pu	2 samples - minimum	1 g	Splitter	Required for blend batch makeup; accountability
Blended powder (5% plutonium)	Tap density	ASTM equal	~ 3–4 g/cc	~1–2 per batch	NDT - 50 g	In-line grab	Simple, quick test - process control
	HM assay/U:Pu ratio	Wet chemistry/ICP mass spec.	~ 88% HM /5% Pu	2 samples - minimum	1 g	Splitter	Required for rod loading; accountability
	Flow properties	Angle of repose		~1–2 per batch	NDT ~200 g	In-line grab	Determines suitability for press feed
	Pellet press test	Press test				Splitter for powder	Press setup for each batch and powder lot changes
	Geom. density vs pressure (3)	Geometric density	~6–7 g/cc	Pellets at 3 pressures	~2–6 pellets		
	Defects	Visual	No defects	All pressed pellets	~6–18 pellets		Defects - laminations, cracks, surface defects
	Sintering test - 3 pressures	Sintering test				From press test	Press and furnace setup for ea. batch and powder lot
	Density vs temperature (3)	Geometric density	~10.2–10.6 g/cc	Pressed pellets at 3 temp.	~ 2–3 pellets		Likely will not vary temperature between batches
	Defects	Visual	No defects	All sintered pellets	~ 6–18 pellets		Defects - laminations, cracks, surface defects
Pressed pellets (green)	Geometric density	Manual or auto	~6–7 g/cc	20–50 pellets	NDT	Random	Verify powder feeding and press parameters
	End dimensions	Manual/visual		20–50 pellets	NDT	Random	Chamfered and dished ends
	Defects	Visual	No defects	20–50 pellets	NDT	Random	Defects - laminations, cracks, surface defects
Sintered pellets	Geometric density	Manual or auto	10.4–10.5 g/cc	20–50 pellets	NDT	Random - no. of boats	Verify batch sintering; setup up grinder
	End dimensions	Manual/visual		20–50 pellets	NDT	Random	Chamfered and dished ends
	Defects	Visual	No defects	20–50 pellets	NDT	Random	Defects - laminations, cracks, surface defects
Sintered/ground pellets	Defects	Visual	No defects	All pellets	NDT - sort	On-line	Defects - laminations, cracks, surface defects
	Surface finish	Surface analysis	32–64 RMS	20–50 pellets	NDT	Random	
	Diameter	Laser/roller micrometers	~0.327 in. (PWR)	All pellets	NDT - sort	On-line	Sort as undersize, correct, and oversize diameter
	End dimensions	Manual/visual		20–50 pellets	NDT	Random	Chamfered and dished ends
	Geo. density	Manual or auto	10.4–10.5 g/cc	20–50 pellets	NDT	Random	
	Density stability	Sintering tests	10.4–10.5 g/cc	10–20 pellets	Pellet	Random	Additional densification not allowed
	Microstructure	Ceramography	Grain size, porosity	2–4 pellets minimum	Pellet	Random	All closed porosity: pore size distribution
	Homogenuity	Polished section/alpha-alpha autoradiograph		2–4 pellets minimum	Pellet	Random	
	O:M	TGA	1.99–2.01	2–4 pellets minimum	1 g	Random	
	Gas release (H_2 and moisture)	Vacuum fusion - mass spec. or GC	1–5 ppm hydrogen	2–4 pellets minimum	1 g	Random	Hydrogen primary gas, determine by fusion method
	Impurities	ICP - emission spec.		2–4 pellets minimum	0.1 g	Random	
	Isotopics	TIMS****/wet chemistry/ ICP mass spec.		2–4 pellets minimum	0.1 g	Random	Likely required when lots crossed in recycle
	HM assay/U:Pu ratio	Wet chemistry	~88% HM/~ 5% Pu	2–4 pellets minimum	1 g	Random	Accountability, rod fuel loading
	Halides (Cl) & misc. impurities	Ion chrom. or wet chemistry		2–4 pellets minimum	1 g	Random	Wet chemistry difficult analysis

* Analytical values have errors associated with sampling and the analysis technique. The magnitude of these errors (particularly sampling) and the statistical confidence required will establish the sampling plan. Also, process capability studies will be required to establish values for statistical process control.

** Grab sampling may not provide the sampling statistics required.

***The UO_2 and PuO_2 should be supplied in as large of powder lots as practical to minimize lot qualification tests.

**** TIMS = thermal ion mass spec.

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Attachment 5
MATRICES FOR ESTIMATING PROJECT COST

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Attachment 5. MATRICES FOR ESTIMATING PROJECT COST

NOTE: The process outlined in this attachment for estimating cost of the candidate options for the LA project was abandoned because of the burden it placed on the sites to produce a cost estimate based on meager design detail. Instead, ORNL and the Site Evaluation Team (SET) agreed to produce the cost estimates with input from the sites using the 103-task project template described in Sect. 1.5.2 and Appendix C. This attachment is maintained because it provides useful information on spatial and equipment requirements that was used by SET in making the estimates.

1. GENERAL INSTRUCTIONS

This attachment provides instructions for completing the cost matrices for estimating project cost. The matrices for three major cost categories—facility construction, process equipment, and analytical equipment—are identified on the first four pages of the matrices. Instructions for these cost categories are generally discussed in the next paragraph. The remaining cost categories are generally discussed in the subsequent two paragraphs. More detailed instructions are provided below.

The functional requirement is listed along with the equipment/facility description, assigned cost ($K), equipment size (ft), and minimum space required (ft^2). Where blanks exist in these columns and where applicable, the sites are urged to fill in the blanks for completeness. The sites are requested to fill in the "Existing (Y/N)" column. Subsequently, if the response is "Y" in the existing column, the procurement cost is $0 except for ancillary equipment items that may need to be purchased. If the response in the existing column is "N," the procurement cost is the assigned cost. The site is also requested to fill in the additional columns (upgrades for order compliance and other modification, labor, or installation cost). These last two columns include materials, equipment, labor, and other costs to accommodate the function. The sites are urged to provide details of these costs on separate sheets to support the summary cost matrices and to allow as much validation of completeness as possible by SET.

For the matrices of permits and authorizations, postconstruction startup, and other nonannual costs, the sites are requested to fill in the cost columns for these activities. Comments may be provided to clarify the costs or functional requirements. In addition, a detailed breakdown of these costs is requested.

For the staffing matrix, the sites are requested to provide staffing costs by providing the total number of personnel required in each category, average salary, and overhead (OH) by category. The sites may provide total staffing costs, but when completing the electronic version of these matrices the total cost will be determined electronically in the spreadsheet by multiplication of the number by the sum of the salary and OH columns. Again, a detailed breakdown of these costs (personnel assigned to functions/shifts) is requested.

2. DETAILED COST MATRIX INSTRUCTIONS

The spreadsheet templates issued to the sites by SET are intended to aid the sites in preparing cost estimates and SET in evaluating those estimates. Providing a template will ensure that all sites report costs in a similar manner with comparable traceability.

The intent of the spreadsheets is that data must only be entered once. The interlinked spreadsheets will track any secondary impacts of those costs, unless a responder chooses to overwrite one of the general assumptions built into the spreadsheets (i.e., Construction Management = 5% of all other construction costs). The spreadsheets are protected to prevent inadvertent overwriting of the built-in assumptions, but they are not password protected, so they may be altered should a site decide it is necessary.

These spreadsheets provide an equipment list and equipment purchase costs, with provision for sites having available existing equipment to take credit for that equipment. Unless the site is taking credit for existing equipment, please use the equipment costs in the spreadsheet (in the assigned cost column). Because the equipment required for the facility should be the same, regardless of site, we have included this to allow you to concentrate on those items unique to your site and not be burdened with common items. All costs are to be reported in thousands of fiscal year (FY) 1998 constant dollars.

The spreadsheets can be categorized as follows:

Cost Category	Spreadsheets
Nonannual Costs:	
Construction and Equipment Costs	1. Facilities Construction Estimates 2. Process Equipment Estimates 3. Analytical Equipment Estimates
Other Startup Costs	1. Permits and Authorizations 2. Postconstruction Startup
Other Nonannual Costs	1. Other Nonannual Costs (contains some front-end and some closing costs)
Annual Costs	1. Staffing 2. Other Annual Costs (includes all annual costs other than staff salaries)

Filling out the Spreadsheets:

1. Facility Construction Estimates

   Please fill in the last four columns.

   Indicate if an item is Existing (Y/N) at your site.

   Insert the proper cost in the Procurement Cost column. If you have the item, enter zero; otherwise enter the SET Assigned Cost or, if one is not given, estimate your cost to procure this item.

   In Upgrades for Order Compliance column, please indicate any facility or site costs that will be incurred to operate this facility compliant with current DOE orders. Because this program is new, it will mean a new function is being performed. It cannot be assumed that existing site exemptions to DOE Orders will apply unless explicitly confirmed.

   List the costs of modifying existing facilities including labor and other costs in the Other Modification, Labor, or Installation Cost column. Note that design costs are to be included in the "Other Nonannual Costs" (No. 6 below) spreadsheet, not here. If you add any items we have forgotten or omitted please list under the "Other" item (No. 25) and explain what you are adding in the "Description" column.

2. Process Equipment Estimates

   Please fill in the last four columns. The guidelines are the same as for Facilities Construction Estimates.

3. Analytical Equipment Estimates

Please fill in the last four columns. The guidelines are the same as for Facilities Construction Estimates.

4. Permits and Authorizations

   This sheet requests cost estimates for obtaining new permits and modifying existing permits. If we have not listed a permit or authorization you will be required to include, please enter it under Item No. 9 "Other" and explain. You may indicate in the Comments column any information you wish to mention about the estimate.

5. Postconstruction Startup

   This sheet is divided into two parts. The first part, Postconstruction Startup, is designed to capture the startup costs of the facility that **do not** include the salaries of those working in the facility. These data should be entered in thousands of dollars just as the preceding data.

   The second section Post Construction Startup Durations, is designed to identify the amount of time, on average, that will be spent in at least the three startup phases listed: Site Training, Cold Startup, and Hot Startup. If you anticipate other phases, please list them under Item No. 4 "Other" and describe. Please note that this is **not to be entered as dollars** but rather as the average number of months the staff of the facility will be engaged in this activity prior to operations. The total of these will be used with the average annual salary cost to calculate the cost of startup attributable to salaries.

6. Other Nonannual Costs

   This is a more general sheet that is intended to cover both startup and closeout costs not covered elsewhere.

   "Design Costs" should reflect the cost to plan and design all modifications to existing facilities as well as designing any new facilities.

   "Indirect Construction Costs" may be $0.00, if your estimates for the costs of construction in equipment installation in the Facilities Construction Estimates, Process Equipment Estimates, and Analytical Equipment Estimates sheets included indirect costs of construction (temporary construction offices, equipment rental, etc.). If those estimates did not include such costs, please enter these costs here.

   "Construction Management" is called out separately here. It is normally 5% of the other construction costs. Unless you have a reason to use a different percentage or value, you may leave this cell alone and it will calculate the correct amount from your other estimates for you. If you change it, please put an "X" in the box beside the estimate, so we will note it, and explain it in the column at the far right, Site Comments.

   "Initial Spares" is also calculated for you. This is a general allowance for spare equipment above the equipment list. The actual items purchased will be determined later in the project. This is for equipment that can be used when there are outages of critical equipment. If you feel you have a reason to override this calculated number, please enter you estimate, and place an "X" in the box at the right of the estimate and explain your estimate in the column at the far right, Site Comments.

   "Decontamination and Decommissioning" should include the cost of returning the proposed facility to the current condition. If that facility is currently contaminated, this category is intended to capture only the incremental cleanup costs resulting from the LA effort, not the entire cost of D&D for the facility.

7. Staffing

This sheet is intended to capture the costs of salary and overhead for the staff of the MOX facility and ancillary staff. We have listed 14 Exempt classifications and 13 Nonexempt classifications. Please enter any we have overlooked under "Other" in the appropriate category.

The Number is the number of each type of staff member you plan during each year of the facility operation (3 years).

Average Salary is the average salary (in FY 1998 dollars) for each type of staff member.

Average Overhead (Average OH) should include fully burdened overhead. It should include all site and facility overhead (not covered elsewhere such as in a facility ft^2 tax) as well as direct overhead items such as benefits.

In the electronic version, the other columns and totals will be calculated using the inputs in these three columns.

8. Other Annual Costs

This sheet captures all annual costs not covered by salaries.

"Process/Operating Materials and Supplies" include items that must be purchased to complete the production of MOX that will not be provided to the site. Please enter the expected annual cost. Do not double count and include anything covered by another cost estimate, such as facility tax or average (staff) overhead. If this is included in another cost category in your estimates, please indicate in the Site Comments column.

Enter the annual estimate of all purchased utilities in "Utilities." Again, be careful of double counting. If this is included in another cost category in your estimates, please indicate in the Site Comments column.

"Replacement Equipment and/or Upgrades" is normally 5% of original equipment. If you do nothing, that estimate will be calculated from the other sheets and entered here. If you wish to change this estimate, please put an "X" in the box at the right of your estimate and explain under Site Comments.

"Waste Handling" includes the on-site costs of collection, processing, storing, and handling the various waste forms. Please enter your expected annual costs (not covered elsewhere).

"Waste Disposal" is the cost of actually disposing of the wastes.

"Oversight" would include any DOE field office "site tax" as well as any reimbursable oversight needed.

"M&O Contractor Fees" is calculated as 2% of other annual costs. If you decide to use a different estimate place an "X" in the cell to the right of the estimate and explain under Site Comments.

"Payment to Local Communities and Counties in Lieu of Property Taxes" would include only the part of such payments that would be charged to this mission, if any.

The “Analytical” costs would be any annual amount spent not included as salary, equipment upgrade, or materials. The most likely would be an on-site laboratory analysis on a fee-for-use basis.

“Transportation” is for on-site transportation only (where applicable). Transportation of material to the site and of finished bundles from the sites will be estimated by SET.

“Infrastructure Tax” includes any site changes based on building usage. It has also been called a square foot tax or a facility fee. The estimate should be the expected annual fee for the facility (facilities) you are proposing. On the following line, indicate the tax per square foot.

9. Project Summary

This is a summary sheet only. It is designed to collect the information from all the other sheets and summarize it in a form much like that used for the rest of the plutonium-disposition program. If the total cost reported there is not equal to your estimate for the program, please alert the SET cost member.

Facility Construction Estimates

	Function (include only items not covered elsewhere; if elsewhere, please note where)	Equipment/Facility Description	SET Assigned Equipment Cost ($K)	Equipment Size (ft)			Minimum Space Required (ft^2)	Existing (Y/N)	Procurement Cost ($K) (use default value shown or replace as appropriate)	Upgrades for Order Compliance Cost ($K)	Other Modification, Labor, or Installation Cost ($K)
				L	W	H					
	Facilities										
1	Main process	See Process Equipment Estimates					5,000				
2	Storage vault/area	Space with racks	50	40	4	6	400				
3	Bundle assembly/ inspection (horizontal/vertical)	Strongback rack	500	40	10	20	1,000				
4	Bundle storage/shipping (vertical/horizontal)	Vertical rack	100	40	8	6	600				
5	Waste packaging (LLW, TRU)	Drum packaging					400				
6	Laundry	Washers, dryers, tanks					500				
7	Maintenance	Shop machine					1,000				
8	Health and safety	H&S equipment					400				
9	Medical services	Medical support					400				
10	Radiation including criticality monitoring	Personnel and facility monitors					400				
11	Change rooms	Male and female					2,000				
12	Sanitary	Tanks, pumps					1,000				
13	HVAC and HEPA filter systems	Ducting, filter housings, air conditioning					500				
14	Compressed gas systems (H_2-A, A, He, N_2)	Tank truck (leased), bottle rack					1,000				
15	Training	Training room					500				
16	Emergency power (e.g., sintering furnace, lights)	Generator, power distribution					400				
17	SST shipment	Dock, space, forklift					2,000				
18	Waste storage	Room, (300 drums), forklift					2,000				
19	Waste shipping	Forklift					500				
20	Security systems:										
	a. physical protection	Barriers, etc.									
	b. MC&A	Computers (measurement covered elsewhere)					200				
21	a. Site-use office space No. of offices = _____	Office equipment					100 each				
	b. Consortium office space (5 offices)	Office equipment					500				
22	Chemical storage	Process chemicals					500				
23	Warehouse	Supplies storage, forklift					4,000				
24	Site support										
	(a) Electrical										
	(b) Sewer										
	(c) Water										
	(d) Fire protection										
	(e) Roads										
	(f) Security										
25	Other (list and explain)										
	Facility subtotals						25,200		$0	$0	$0

Process Equipment Estimates

	Function (include only items not covered elsewhere; if elsewhere, please note where)	Equipment/Facility Description	SET Assigned Cost ($K)	Equipment Size (ft)			Minimum Space Required (ft^2)	Existing (Y/N)	Procurement Cost ($K) (Use default value shown or replace as appropriate)	Upgrades for Order Compliance Cost ($K)	Other Modification, Labor, or Installation Cost ($K)
				L	W	H					
	Process Equipment										
1	Receive/inspect PuO_2	Space with balance, inspection	250	6	3	3					
	Glove box		100	8	3.5	5	90				
2	Store PuO_2	Space with rack	10								
	Glove box		100	8	3.5	5	90				
3	Receive/inspect UO_2	Space with balance	50	6	3	3	100				
4	Store UO_2		5	10	5	5	100				
5	Receive/inspect hardware	Space with inspection	100	40	8	4	320				
6	Store hardware		5	40	4	4	160				
7	Master blend/mill	High intensity blender/mill	50	3	3	4					
	Glove box		100	8	3.5	5	90				
8	Final blend	Low intensity blender/mill	50	3	3	4					
	Glove box		100	8	3.5	5	90				
9	Prepress (slug)	Small hydraulic press	350	3	3	5					
	Glove box		100	8	3.5	5	90				
10	Granulate	Granulator/spheorodizer	20	3	3	3					
	Glove box		100	8	3.5	5	90				
11	Press (including dies)	Small hydraulic press	500	3	3	5					
	Glove box		100	8	3.5	5	90				
12	Sinter (including boats)	Continuous ceramic muffle furnace	1,000	16	5	5					
	Glove box		150	20	9	9	180				
13	Grind	Small centerless dry grinder	50	5	3	3					
	Glove box		100	8	3.5	5	90				
14	Inspect pellets (dimensional, density, visual)	Laser micrometer, optical comparator, visual standards	100	3	3	3					
	Glove box		100	8	3.5	5	90				
15	Store pellets		20	6	3	3					
	Glove box		100	8	3.5	5	90				
16	Weld 1st end plug	Small welder	100	3	3	5					
	Weld chamber	Small chamber with vacuum tube	250	20	3	3	200				
17	Load rods	Loading rack with measurement and balance	100	20	3	3					
	Glove box		100	8	3.5	5	180				
18	Weld rods/pressurize	Welding box with vacuum tube and pressurization	650	40	4	4	160				
19	Inspect rods										

Process Equipment Estimates

	Function (include only items not covered elsewhere; if elsewhere, please note where)	Equipment/Facility Description	SET Assigned Cost ($K)	Equipment Size (ft)			Minimum Space Required (ft^2)	Existing (Y/N)	Procurement Cost ($K) (Use default value shown or replace as appropriate)	Upgrades for Order Compliance Cost ($K)	Other Modification, Labor, or Installation Cost ($K)
				L	W	H					
	Process Equipment										
	X-ray	Weld inspection	100	40	6	5	240				
	Passive/Active Neutron	Rod scan	500	40	6	5	240				
	Leak test	Rod leak detector	100	40	6	5	240				
	Surface table	Rod straightness/visual	100	20	6	4	120				
	Gamma scan	Rod scan	350	40	6	5	120				
20	Store rods	Storage rack	20	40	4	6	160				
21	Store scrap	Storage rack	10	6	3	3					
	Glove box		100	8	3.5	5	90				
22	Process scrap	Crusher, mill	250	6	3	3					
	Glove box		100	8	3.5	5	90				
23	Store waste	Storage rack	10	6	3	3					
	Glove box		100	8	3.5	5	90				
24	Process waste	Compactor	250	6	3	3					
	Glove box		100	8	3.5	5	90				
25	R&D capability		100	6	4	4					
	Glove box		100	8	3.5	5	90				
26	Accountability measurement	PuO_2, MOX waste, rod measurement	750	40	20	8	800				
27	PWR to BWR	Capability to fab BWR fuel	100	N/A	N/A	N/A					
28	Other (list and explain)										
	Process Equipment Subtotals						4,670		$0	$0	$0

Analytical Equipment Estimates

	Function (include only items not covered elsewhere; if elsewhere, please note where)	Equipment/Facility Description	SET Assigned Cost ($K)	Equipment Size (ft)			Minimum Space Required (ft²)	Existing (Y/N)	Procurement Cost ($K) (Use default value shown or replace as appropriate)	Upgrades for Order Compliance Cost ($K)	Other Modification, Labor, or Installation Cost ($K)
				L	W	H					
	Analytical Equipment										
1	Pu/PuO_2	ICP mass spec.	30	5	3	3					
2	Pu/U isotopics	Thermal ion mass spec.	1,000	10	10	8	400				
3	U/UO_2	ICP mass spec.	Included above in Item No.1.								
4	Sieve and subsieve	Sieves, Fisher subsieve	100	5	5	4					
5	Tap density	ASTM equal	5	2	2	2					
6	Ceramography	Ceramography stations	100	6	3	3					
	(a) Grain size	Microscope	50	2	2	3					
	(b) Homogeneity (incl. stds)	Alpha autoradiography	30	3	3	3					
	(c) Porosity	Microscope	Included above in Item No. 6a.								
7	Volatiles	Vacuum fusion, GC	500	10	10	8	400				
8	Surface area	BET	50	4	3	3					
9	Moisture content (incl. H_2)	TGA, high temp.	100	4	3	3					
10	Impurities	ICP emissions spec.	1,000	10	10	8	400				
11	O/M	Thermal gravimetric analysis	50	4	3	3					
12	Chemistry panel (Ga, Cl, F, S, P, N, etc.)	Wet chemistry, ion chrom.	500	10	10	8					
13	Glove boxes (no. required__________)	Cost and dimensions of each =	100	8	3.5	5	90				
14	Other (list and explain)										
	Analytical Equipment Subtotals						1,290		$0.00	$0	$0

Permits and Authorizations

	Item	Total Cost ($K)	Comments
	Permits & Authorizations		
1	NEPA/EIS		
2	Licensing/DNFSB		
3	Permitting:		
	1. State/local		
	2. Safety authorization		
4	Construction permits (if applicable and not covered under construction)		
5	SAR		
6	Quality assurance plan		
7	Site qualification		
8	Site safequards & security plan		
9	Other (list and explain)		
	Permits & Authorizations Subtotal	$0	

Postconstruction Startup

	Function (include only items not covered elsewhere; if elsewhere, please note where)	Procurement Cost ($K)	
	Postconstruction Startup (**do not include** salaries of staff listed under salaries)		
1	Training (other than staff salaries)		
2	Security clearences		
3	Procedure and manual preperation		
4	Operational readiness reviews		
5	Other startup costs (list and explain)		
	Postconstruction Startup Durations		**Time/ Duration** (in months)
1	Site training (avg. time/staff member)		
2	Cold startup (avg. time/staff member)		
3	Hot startup (avg. time/staff member)		
4	Other staff time, not included in regular operation (avg. time/staff member)		
	Postconstruction Startup Subtotal	$0	0

Other Nonannual Costs

Please enter **total** estimate for an item, **not** an annual estimate. Explain in "Site Comments."

	Item	Total Cost ($K)	Note	SET Comments/Instructions	Site Comments
1	Design costs			*This design should cover all facilities and processes.*	
2	Indirect construction costs			*If these costs (i.e., storage, subcontractor offices; see instructions for detailed list) are included in the detailed estimates, enter $0. Otherwise enter estimate.*	
3	Construction management	$0		*Default is 5% of construction costs (Totals for Facility, Process Equipment, Analytical Equipment, Monitoring & Instrumentation; including "Modification or Installation"). If you change, please indicate by placing "x" in the box at left.*	
4	Initial spares	$0		*This included any equipment planned to have in hand at startup to be used as spares and is not included in equipment costs. [The default is 5% of initial equipment (Procurement costs)]. If you change this estimate please indicate by placing an "x" in th*	
5	Decontamination and decommissioning			*Include all costs needed to return a facility to its original status or to completely D&D depending on site expectations of future use of facilities.*	
6	Other nonrecurring/nonannual costs (please list and explain)				
	Total "Other Nonrecurring/Nonannual Costs" (sum Item No. 4)	$0			
	Total "Other Nonannual Costs" (sum all Items)	$0			

Staffing

	Position (include only what is not covered elsewhere; if elsewhere, please note where)	Number	Average Salary ($K)	Average OH ($K)	Average Total Cost per Person ($K)	Total Cost
Please enter average values for annual operations.						
Exempt						
1	Managers				$0	$0
2	Process engineers				$0	$0
3	Maintenance engineers				$0	$0
4	Accountability				$0	$0
5	Quality assurance				$0	$0
6	Security				$0	$0
7	Analytical*				$0	$0
8	(On-Site) Transportation*				$0	$0
9	Radiation protection				$0	$0
10	Safety				$0	$0
11	Fire				$0	$0
12	Medical				$0	$0
13	Financial				$0	$0
14	Personnel				$0	$0
15	Other exempt (list and explain)				$0	$0
					$0	$0
					$0	$0
					$0	$0
					$0	$0
	Total Exempt	0				$0
Nonexempt						
1	Process operators				$0	$0
2	Maintenance				$0	$0
3	Accountability				$0	$0
4	Quality assurance				$0	$0
5	Security				$0	$0
6	Analytical*				$0	$0
7	(On-Site) Transportation*				$0	$0
8	Radiation protection				$0	$0
9	Safety				$0	$0
10	Fire				$0	$0
11	Medical				$0	$0
12	Stores				$0	$0
13	Clerical				$0	$0
14	Other nonexempt (list and explain)				$0	$0
					$0	$0
					$0	$0
					$0	$0
					$0	$0
	Total Nonexempt	0				$0
	Total Annual Personnel	0				$0
*	May be included in items on "Other Annual Costs"					

Other Annual Costs

	Item	Total Cost Per Year ($K)	Note	SET Comments/Instructions	Site Comments
	Please enter average values for annual operations. If an item is included elsewhere please indicate under "Comments."				
1	Process/operating materials and supplies				
2	Utilities				
3	Replacement equipment and/or upgrades	$0		*The default is 5% of original equipment per year. You may enter a different value by overwriting the equation. If you do, please enter an "x" in the box at the left.*	
4	Waste handling			*Includes transuranic waste, RCRA waste, low-level rad waste, and mixed waste.*	
5	Waste disposal (including transportation of waste)			*Includes Transuranic waste, RCRA waste, Low-level Radwaste, and mixed waste*	
6	Oversight			*Include NRC, DOE, state, and local reimbursed oversight costs.*	
7	M&O contractor fees	$0		*Default is 2% of annual costs, including Staffing. You may change it; if you do, please enter an "x" in the box at left.*	
8	Payment to local communities and counties in lieu of property taxes (PILT)			*If such payments for the site might be expected to increase with the addition of this facility, please enter that estimate here. If this is covered elsewhere, enter $0.*	
9	Analytical (unless covered in Staffing spreadsheet)*			*All or part may be covered under "Salaries." Include only that part not covered elsewhere here.*	
10	Transportation (on-site)*			*All or part may be covered under "Salaries." Include only that part not covered elsewhere here.*	
11	Infrastructure tax (space and support cost based on ft^2)			*Please include all of the expected annual infrastructure tax here.*	
	Infrastructure tax per ft^2			*Please include only the expected annual infrastructure tax per ft^2 here.*	
12	Other annual costs (please list and explain)				
	Total Other Annual Costs	$0			
	Total Annual (Non-Salary) Costs	$0			
*	All or part of this may be reported under staffing. Please do not "double count."				

Project Summary

	Costs in 1998 $K	MOX LA Facility	
	Cost type	Lump-sum ($K)	Annual ($K/year)
	Years of operation =	3	
	Preoperational or "OPC"		
	Up-front costs		
1	R&D	N/A	
2	NEPA, licensing, permitting, Q/A, site qualification, S&S	$0	
3	Conceptual design	N/A	
4	Q/A, site qualification, S&S	In Category No. 2 above	
5	Postconstruction start-up	$0	
6	Risk contingency	N/A	
	SUBTOTAL OPC	$0	
	Capital or "TPC" front-end costs (TEC)		
7	Design	$0	
8	Capital equipment + direct & indirect construction/modification	$0	
9	Construction management	$0	
10	Initial spares	$0	
11	Allowance for indeterminates (AFI)	N/A	
12	Risk contingency	N/A	
	SUBTOTAL (TEC)	$0	
	TOTAL UP-FRONT COST (TPC)	$0	
	Other life-cycle costs		
	Annual costs		
13	Operations and maintenance staffing	$0	$0
14	Consumables including utilities	$0	$0
15	Major capital replacements or upgrades	$0	$0
16	Waste handling and disposal	$0	$0
17	Oversight	$0	$0
18	M&O contractor fees (2% of categories 13-16)	$0	$0
19	Payments-in-lieu-of-taxes to local communities	$0	$0
	Other (nonsalary) annual costs	$0	$0
	Total Annual Costs	$0	$0
	Nonannual Costs		
20	D&D	$0	
	Other nonannual costs	$0	
21	Revenues (if applicable) MOX or electricity	N/A	
22	Gov't subsidies or fees to privately-owned facility	N/A	
23	Transportation of plutonium forms to facility	N/A	
	TOTAL OTHER LCC	$0	
	GRAND TOTAL ALL LCC	$0	

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Attachment 6
OUTLINE FOR SITE PLANS

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Attachment 6. OUTLINE FOR SITE PLANS

1. Introduction
   a. Proposed Option
   b. Executive Summary

2. Facility Description
   a. Existing Facility Status
   b. Previous Use
   c. Advantages for MOX Fabrication Utilization

3. Site Infrastructure
   a. Utilities
   b. Security
   c. Fire Protection
   d. Analytical Laboratories
   e. Waste Handling
   f. Support Services
   g. Regulation and Permitting
   h. Safety
   i. Other

4. Process Interface Descriptions
   a. Feed Material Receiving
   b. Feed Storage
   c. Blending
   d. Pellet Production and Inspection
   e. Rod Assembly and Inspection
   f. Rod Storage
   g. Bundle Assembly
   h. Bundle Storage
   i. Packaging and Shipping
   j. Waste Handling

5. Proposed Facility Modifications
   a. To Install MOX Fuel Fabrication Equipment
   b. To Accomplish DOE Order Compliance

6. Resources and Manpower Discussions
   a. Design
   b. Construction
   c. Operation

7. Environmental Compliance
   a. Permitting
   b. Effluent Monitoring
   c. Waste Generation

8. Cost and Schedule

Outline for Site Plans (cont.)

9. Variance from Baseline Discussion
    a. Site Variances that Increase Cost or Schedule
    b. Site Variances that Decrease Cost or Schedule
    c. Facility Variances that Increase Cost or Schedule
    d. Facility Variances that Decrease Cost or Schedule

10. Response to Questionnaire
    a. Discussion
    b. Cross-Reference Matrix

11. Cost and Schedule Risk

12. Conclusions

Attachment 7
SITE/FACILITY QUESTIONNAIRE

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Attachment 7. SITE/FACILITY QUESTIONNAIRE

NOTE: The questionnaire presented here is the revised version issued to the sites when the plans for producing the LA cost estimates changed from a site-produced estimate to an estimate produced by SET with input from the sites.

A. MANAGEMENT/PERSONNEL

1. Does this mission have site management commitment and does it not adversely affect other site activities? Please consider site status (operating vs remedial action, external constraints, etc.).
2. Is/are the facility(ies) proposed for the LA MOX fabrication mission uncommitted for other potential missions within the time frame of this project or free of any conflicts with other planned or ongoing missions? If not, identify other planned or potential missions and explain interfaces and potential conflicts.
3. Is the proposed lead assembly mission free of potential adverse affects on the future MOX production program if this site also was selected for the production mission?
4. Will uncleared and/or foreign personnel be permitted to routinely access the proposed LA MOX fabrication and assembly areas? What delays are expected from time of request to entrance? Will escorts be required?
5. Is the current program for protection and control of classified materials adequate to support the LA MOX mission and can classified and/or proprietary information be protected from uncleared foreign nationals? What measures are planned to protect such information?
6. Are there provisions at the proposed site for protecting consortium proprietary information? What measures are planned to protect such information?
7. Identify available exempt and non-exempt personnel with direct significant MOX fabrication experience (key names and total number).
8. Are there existing training organizations and facilities at the proposed site to adequately address required radiation worker training, respirator training and fitting, glove-box training, criticality training, etc.? Describe existing capabilities and discuss the expansions needed in training resources needed to support specific LA MOX operations training.
9. Are Personnel Security Assurance (PSAP) and Fitness for Duty programs in place and are sufficient qualified personnel available to meet LA MOX mission requirements? Provide an estimate of any additional requirements.
10. Are sufficient personnel available with the necessary security clearances? If additional security clearance requirements are necessary, provide an estimate of the number of people and type of clearance required.

B. SITE/RESERVATION SPECIFIC

1. Do the proposed LA MOX fabrication activities fall within existing site EIS and NEPA documentation? If not, what level of effort will be required to provide the required authorization/documentation?
2. Does the proposed site have existing external oversight agreements with local or state agencies and/or other stakeholder groups? Is it anticipated that these may adversely impact LA MOX siting and/or operations? Explain how these agreements might need to be amended to accommodate a LA MOX project.
3. Are existing fire department facilities appropriately located and adequately staffed and equipped for protection of the planned LA MOX facilities? If not, explain the physical and/or staffing changes needed to support the LA MOX production activity.
4. Are the existing medical support facilities and first-aid stations appropriately located and adequately staffed and equipped for the planned LA MOX mission? If not, explain the physical and/or staffing changes needed to support the LA MOX production activity.

5. Are the existing site emergency response plans, staffing, and control center adequate for the planned LA MOX mission? If not, explain the physical and/or staffing changes needed to support the LA MOX production activity.
6. Are existing site-wide emergency planning and preparedness programs integrated with local, county, and state agencies and adequately staffed and equipped for the planned LA MOX mission? If not, explain the physical and/or staffing changes needed to support the LA MOX production activity.
7. Does the proposed site have an active nuclear safety/criticality program implemented for the prevention of inadvertent nuclear safety/criticality occurrences, and is the program adequately staffed and equipped for the planned LA MOX mission? If not, explain the physical and/or staffing changes needed to support the LA MOX production activity.
8. If the proposed site is required to have safety, radiation protection, regulatory, quality assurance, or other similar oversight committees for missions such as the proposed LA MOX fabrication mission, do such oversight bodies currently exist and have adequate staffing? Describe responsibilities and programs.
9. Are programs for operations security (OPSEC); technical surveillance countermeasures (TSCM); and foreign ownership, control or influence (FOCI) adequate to support the LA MOX activities? If facility upgrades or staffing enhancements are necessary, explain.
10. If the proposed plan requires intrafacility movement of SNM between processing steps, are qualified facilities, services, and packagings available for intrafacility movement of the SNM? If not, explain impact of providing these resources. If yes, briefly describe the available resources.
11. Is the existing site safeguards and security plan (SSSP) adequate to address the needs of the proposed LA MOX mission? If not, explain the physical and/or staffing changes needed to support the LA MOX production activity.

C. PROPOSED FACILITIES

1. Do the proposed facilities currently have sufficient qualified space for the main process operation to support LA MOX fabrication activities (an estimated 5000 ft^2 is required)? Describe adequacy of available space and/or anticipated efforts required to establish or modify space.
2. What is the current hazard category for the proposed facilities? Will LA MOX fabrication activities result in an increase of the hazard category? Discuss briefly.
3. Are the proposed facilities being established/modified solely for this mission? Is there a continuing mission for these facilities independent of the LA MOX activity?
4. What is the current operational status of the proposed facilities? Are they in active operational status or are they in legal compliance shutdown/inactive status under DOE-EM jurisdiction? Discuss briefly.
5. What is the status of safety basis documentation (i.e., SARs, ISBs, BIOs with respect to DOE Standards and DOE Order 5480.23) for the proposed facility(ies)? Will the LA MOX fabrication activities fit within the scope of the existing safety documentation for the proposed facilities? If not, discuss the extent of the changes needed in and resources required to modify safety basis documentation.
6. Are any waivers or exceptions to applicable local, state, or federal laws or DOE directives anticipated as a part of this mission? Discuss briefly.
7. Are there currently identified noncompliances to DOE directives for any of the proposed facilities? If so, list the existing noncompliances and identify those that likely will need to be corrected prior approval of the proposed facility(ies) for the LA MOX mission. What are the estimated costs of making the required corrections?
8. Are the existing maintenance facilities, equipment, and support agreements adequate for planned LA MOX activities? List deficiencies, if any.

9. Are the proposed facility areas currently contaminated? If so, what are the types and levels of contamination? Will decontamination be required prior to facility modifications/construction? Is there a current D&D Plan for the proposed facility(ies). If so, briefly describe the current plans and explain how they are impacted by this proposed use. What is the proposed incremental D&D effort after LA MOX activities are completed?
10. Does/do the proposed facility(ies), or do other available on-site facilities, have the capability for performing off-line process/fabrication technical support (i.e., dealing with powders having unusual characteristics, improving measurements, and analytical techniques)? Briefly discuss these resources.
11. Do provisions exist on site for handling and storage of TRU-contaminated equipment (e.g., pellet press dies, centerless grinding components, and rod loading jigs) from the proposed LA MOX activities? If not, describe needed changes.

CA. Receiving and Vault Storage—SNM Category 1; Hazard Category 2

1. Do vaults and/or vaultlike rooms exist for the storage and processes associated with the LA MOX mission? If not, explain.
2. Is the hazard classification and allowed SNM quantities for the proposed facility(ies) adequate to support the LA MOX mission? What are the allowed facility SNM quantities and isotopes and hazard classification (please explain the bases in terms of compliance with DOE Order 5480.23)?
3. Are proposed SNM storage areas operational, and do they meet all applicable requirements for the storage of the planned quantities and types of SNM (PuO_2 powders and MOX powders, pellets, rods and assemblies) for the LA MOX mission? If not, list deficiencies and/or proposed upgrades.
4. Is the safety basis documentation for the storage vault current, and are all hazards represented by the proposed LA MOX mission within the scope of the current authorization? If not, list deficiencies and judgment on the level of effort needed to revise the safety basis documentation.
5. Does the safety basis documentation currently cover the storage of plutonium oxide? If not, explain how plutonium oxide will be addressed.
6. Is the size of the vault storage facility adequate to support the LA MOX mission and any other planned missions? If not, identify how the discrepancy will be addressed. Approximately what percent of the capacity of the vault storage facility will the LA MOX mission require during the MOX activities?
7. Does an adequate shipping/receiving area exist for SST shipments? If not, list deficiencies and/or upgrades that will be needed.
8. Does a nearby area exist where SSTs left unattended overnight can be parked and provided the appropriate security? If such an area exists, identify. If not, how could such an area be created?

CB. Powder, Pellet, and Rod Fabrication—SNM Category 1 or 3; Hazard Category 2

1. What are the allowed relevant SNM quantities and isotopes for the proposed facility? Please explain the bases in terms of compliance with DOE Order 5480.23. List upgrades, if required.
2. Will the proposed powder, pellet, and rod fabrication (PPRF) building structure meet containment requirements for handling significant quantities of dispersible plutonium and uranium oxide powders. Include discussion of external events or natural phenomena hazards and formal seismic analyses that have been performed for the PPRF and the anticipated emissions from normal operations and design-basis accidents?
3. Does the proposed PPRF have a fire-suppression system? Will it be sufficient/appropriate for LA MOX and powder operations? Explain any interaction with criticality controls and with the discharge of contaminated liquids from firefighting activities. Discuss any anticipated upgrades/enhancements.

4. What design features are present in the facility to prevent a criticality event? Does the facility have an acceptable criticality alarm system? Discuss any anticipated upgrades/enhancements.
5. Is the facility currently being used to process/handle PuO_2 or similar nuclear materials? Explain limitations posed by ongoing activities with proposed LA MOX process line.
6. Does the proposed facility provide flexibility in the efficient layout of an LA MOX process equipment line?
   - 6.1 Explain limitations posed by existing glove boxes and/or building features?
   - 6.2 Explain limitations in the modification of the existing glove boxes and/or building features to accommodate an LA MOX process line.
   - 6.3 What is the maximum ceiling height available to allow the use of a gravity-feed processing option?
7. Does the proposed facility currently have any operational prototypic process equipment (e.g., glove boxes and process equipment, see process equipment table in Appendix A.5.) that might be used to fabricate qualified fuel for lead assemblies? Please describe and list the ROM cost value of these items.
8. What are the proposed cold startup and hot startup plans following facility/equipment readiness? Describe the proposed approach for establishing an LA MOX processing baseline.
9. What are the proposed fuel batch sizes for processing (i.e., blending, pellet fabrication)? Briefly describe the planned batch processing strategies, including the sequencing of batches, anticipated holdups quantities (in-line and analytical) and interim storage requirements.

CC. Ventilation System

1. Does the proposed building have an operating HEPA-filtered, zone-controlled ventilation system approved for handling plutonium oxide powders? If yes, would upgrades be anticipated for the LA MOX activities? If no, explain anticipated installation or upgrades to provide an adequate system.
2. What provisions are or will be provided to contain contamination at its source of generation?
3. Explain the relationship of the glove-box off-gas system to the room and to building ventilation systems. Provide a brief description of the ventilation zones.
4. Does the discharge stack have sufficient height and appropriate stack monitoring features sufficient to support the LA MOX activities? If not, explain deficiencies and/or proposed upgrades.
5. Does the facility have inert gas and/or controlled humidity ventilation capability for the powder-blending glove boxes? Describe the proposed approach for glove-box environment control.
6. Have ventilation system components been identified by safety function and qualified to appropriate enhanced criteria based on the safety function? List.

CD. Normal and Emergency Electrical Power

1. Are the capacity, reliability, and availability of the existing normal electrical power distribution systems to and within the facility adequate for planned LA MOX activities? Describe system and component qualifications.
2. Does the proposed facility have an existing emergency/backup power system to accommodate the needs of the LA MOX mission? This should include power for safety-related equipment function (e.g., HVAC and monitoring) and cooling systems necessary for the safe shutdown of the sintering furnace(s) and other equipment. Describe backup or emergency power system capacities and levels of code qualification.

CE. Safeguards and Security (S&S)

1. Are the existing physical protection systems/components (e.g. barriers, detection and assessment, access control, and communications) adequate for the LA MOX mission? If not, list deficiencies and/or upgrades needed.
2. Will the S&S support for the proposed facilities for the LA MOX mission be independent of other site operations (or will it rely on sitewide capabilities such as barriers, central/secondary alarm stations, communications, access control systems, other protective forces, special response forces)? If other site assets are used, identify.
3. Is the existing classified automated information system adequate to support the LA MOX mission?
4. Are any of the proposed facilities to be used for the LA MOX mission under IAEA safeguards now or will they be during the period of this mission? If so, provide details.
5. Are there any materials, information, and/or activities at the facilities to be used for the LA MOX mission that would need to be protected from IAEA inspectors and/or foreign visitors? Explain.

CF. Compliance

1. Will the current facility/site environmental permits meet the requirements of the proposed LA MOX activities? If not, what is the anticipated level of effort required to obtain revised permits?
2. Does the facility have adequate personnel radiological monitoring equipment (including survey, hand and foot counters, and continuous air monitors for plutonium and uranium) available for the LA MOX activity? If not, what supplemental equipment is anticipated?
3. Describe how ALARA considerations will be implemented in the facility to accommodate the LA MOX activities that may include significant americium content.

CG. Other Features Required

1. Does the facility have adequate personnel decontamination and change room facilities for both male and female? If not, how will these capabilities be provided?
2. How will contaminated liquids from decontamination operations (personnel decontamination, safety showers, etc.) be handled? Explain the relationship to existing wastewater treatment facilities.
3. Does the facility have adequate offices for the required operating staff convenient to the facility(ies)? Approximate number available.

D. BUNDLE ASSEMBLY—SNM CATEGORY I; HAZARD CATEGORY 2

1. Is the proposed bundle assembly area located in the PPRF processing facility? If not explain the relationship between the two facilities and answer questions 2 through 4 below.
2. What is the current hazard classification of the proposed facility? What are the allowed SNM quantities and isotopes? (Please explain the bases in terms of compliance with DOE Order 5480.23.)
3. Is the safety basis documentation for the assembly area current, and are all hazards addressed? If not, discuss anticipated approach.
4. Does the safety basis documentation currently cover the handling of MOX fuel? If not, discuss anticipated approach.
5. Briefly describe the vertical space proposed that has a minimum clearance of 20 ft (from the hook of a 1-ton lifting device) for the required vertical inspection of fuel bundles.

E. BUNDLE STORAGE AND SHIPPING—SNM CATEGORY I; HAZARD CATEGORY 2

1. Do adequate facilities exist for the vertical storage and rotation to the horizontal for shipping of the bundles? If not, discuss anticipated approach.
2. Is the proposed bundle storage area located in the proposed receiving storage vault? If not, explain relationship and answer questions 3 through 5 below.
3. What is the current hazard classification of proposed facility? What are the allowed SNM quantities and isotopes? Will these be impacted by the proposed LA MOX activities? (Please explain the bases in terms of compliance with DOE Order 5480.23.)
4. Is the safety basis documentation for the bundle storage facility current, and are all bundle storage and shipping hazards addressed? If not, discuss anticipated issues.
5. Does the existing safety basis documentation cover the handling of MOX fuel? If not, explain how the MOX-related issues will be addressed.
6. Briefly describe how completed bundles will be stored in the proposed facility (e.g., vertical hanging storage array with strongback for horizontal packaging and shipping**)**.

F. WASTE

1. Does the proposed site currently have a transuranic (TRU) waste generator certification plan and the NDT equipment to separate LLW from TRU waste and to certify TRU waste for disposal in WIPP? If not, explain deficiencies. Also, discuss plans for RCRA waste handling, if required.
2. Do you anticipate the treatment (i.e., immobilization for respirable fines) of any of the TRU waste generated? If so, does the proposed site have the required facilities? If not, explain deficiencies.
3. Will the quantities of TRU waste expected to be generated in this LA MOX project have any impact on the TRU waste storage situation at the site, including existing agreements with the state and local governments? Explain this situation for the proposed site.
4. Does the proposed site charge the generators for waste management? If so, what are the ROM costs for waste management for the projected quantities?
5. Does the proposed site have the necessary facilities (either on- or off-site) and/or plans for the interim storage and disposal of the projected quantities of solid LLW? Explain the situation for the proposed site.
6. Does the proposed site have facilities for volume reduction of solid radioactive waste? If so, briefly describe available facilities and their capabilities. If not, discuss the plan for overcoming this deficiency.
7. Does the proposed site have operating facilities for the collection and disposition of contaminated liquids, including sludges, projected to be generated from decontamination of facilities, equipment, and personnel (e.g., shower and mop water)? If not, discuss the plan for overcoming these deficiencies.
8. Are the anticipated liquid, solid, and gaseous waste streams, both radioactive and non-radioactive, consistent with permitted activities at the proposed site? If not, discuss the measures planned to achieve compliance.
9. What are the anticipated waste minimization plans for this LA MOX facility?
10. Describe the waste types and quantities expected to be generated during facility(ies) modifications.

G. ANALYTICAL

1. Does the proposed site currently have operational analytical services capability for the list of analyses required for the LA MOX mission that was provided in Table A.2? Please describe and provide the ROM costs and turn-around times for these analytical services. Identify deficiencies for the required analyses and turn-around times.

2. Does the analytical laboratory have the resources and capability to establish and maintain calibration and certification? If not, what are the plans for overcoming this deficiency?
3. Does the proposed site currently have MOX fuel sampling/quality assurance plans? Briefly describe these plans.

H. PHYSICAL SECURITY

1. Is an adequately equipped and trained Protective Force available on-site, and can it be reinforced within a required response time to protect the SNM for the proposed site? Describe.
2. Is an S&S performance assurance program in place and adequate to support the LA MOX mission (e.g., S&S maintenance, testing, records management)? Describe.
3. Has consideration been given to changes in the site-specific threats resulting from the LA MOX mission? Explain.
4. Has a preliminary vulnerability analysis and risk assessment been done for the LA MOX activities? If yes, briefly describe any key issues.

I. SNM MATERIALS CONTROL AND ACCOUNTABILITY

1. Are the existing material control and accountability (MC&A) systems/components (e.g., nuclear measurements/assays, materials accountability, MC&A computer system) adequate for the LA MOX mission? If not, identify required upgrades.

J. SHIPPING AND RECEIVING

1. Are the LA MOX fuel fabrication facility(ies) transportation systems and shipping/receiving areas for off-site receipt/shipment of SNM adequate for the anticipated quantities of SNM? If not, what modifications are needed?

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Appendix B
PROJECT PERSONNEL

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Appendix B. PROJECT PERSONNEL

DOE AND SITE POINTS OF CONTACT

The contractor and DOE personnel at each candidate site developed plans for conducting the proposed project at their sites, toured SET through the proposed facilities, collaborated with SET in characterizing their option, and commented on preliminary characterizations by SET of the suitability of their respective options. J. H. Thompson, DOE-MD task manager for the development and evaluation of options for fabricating LAs, accompanied SET on the tours of each facility. The DOE and contractor points of contact for the LA site evaluation are listed in Table B.1.

Table B.1. Designated points of contact

Site	DOE contact	Contractor contact
SRS	D. L. Bruner, Savannah River Operations Office	R. L. Geddes, Westinghouse Savannah River Company
ANL-W	J. E. Werner, Idaho Operations Office	D. C. Crawford, ANL-W, University of Chicago
Hanford	J. E. Mecca, Richland Operations Office	D. E. Sandberg, B&W Hanford Company
LLNL	S. El-Safwany, Oakland Operations Office	M. C. Bronson, LLNL, University of California
LANL	M. L. Gates, Albuquerque Operations Office	J. J. Buksa, LANL, University of California

SITE EVALUATION TEAM

SET was composed of persons with a wide range of skills. Sherrell Greene organized SET and served as its official leader. Ray Holdaway directed the day-to-day activities of the team, led it in the site tours and work sessions, and served as the lead author for this report. The core SET members, Bob Carrell, Cal Jaeger, Joe Miller, John Sease, and Marion Thompson, participated throughout the activity. Others, specifically Rebecca Moses, Dan O’Connor, and Al Strasser, supported specific phases. Each team member has specific skills and specific assigned areas of responsibility; however, each member has broad experience and, on key topics, collaborated with other team members with relevant experience to reach consensus. The team members and their assigned areas of responsibility are shown in Table B.2. Professional experience summaries for each team member follow.

Table B.2. Site evaluation team

Name	Specific assignments
R. F. Holdaway	Team leader, principal author
R. D. Carrell	Safety, NEPA permits, operational readiness reviews, DOE Orders, infrastructure
C. D. Jaeger	Safeguards, security, transportation, special nuclear material storage
J. W. Miller	Cost modeling, database support
J. D. Sease	Facility modifications, operations, waste management, decontamination and decommissioning, radiation exposure
M. L. Thompson	MOX and analytical processes, operations, quality assurance
R. J. Moses	Cost and schedule modeling, report integration
D. G. O’Connor	Coordination with EIS data
A. A. Strasser	MOX process and analytical processes

PROFESSIONAL EXPERIENCE SUMMARY

Robert D. Carrell

Robert D. Carrell has 21 years experience in nuclear chemical processing activities at the Hanford Site and other Department of Energy (DOE) facilities. Engineering experience includes nuclear facility safety, facility design, plutonium confinement systems, nuclear process operations, safety analysis, and operational readiness review (ORR). Areas of expertise include spent nuclear fuel; plutonium oxide manufacturing and processing; plant utilities and services; heating, ventilation, and air conditioning; confinement; and fire protection systems. Mr. Carrell has an extensive working knowledge of DOE Orders and other national codes, standards, and regulations. He has worked extensively performing facility safety evaluations and code compliance assessments that compare new and existing DOE nuclear facilities to DOE Orders and other national codes and standards. Mr. Carrell possesses extensive experience in preparation of safety analysis reports and nuclear accident analysis along with incident investigation and root-cause analysis. In addition, Mr. Carrell has participated in several ORRs at the Hanford Site.

Mr. Carrell obtained a B.S. degree in mechanical engineering from Washington State University and is a licensed mechanical professional engineer.

Since 1988, Mr. Carrell has been a consulting engineer with several engineering firms contracting to DOE and private sector contractors. He was lead engineer preparing the safety analysis addendum to the FFTF safety analysis report (SAR) for transfer of light-water reactor spent nuclear fuel from the 300 Area to the Interim Storage Area (ISA) at the 400 Area at Hanford. Mr. Carrell coordinated the relocation of spent TRIGA Fuel from the 308 Building to the 400 Area ISA. Mr. Carrell has also participated in studies for storage cask seal integrity and monitoring requirements. Mr. Carrell participated on the Plutonium Disposition Team for General Electric Company (GE). He provided functional design criteria and developed the conceptual design report for a pool-type independent spent fuel storage facility to be used in conjunction with the GE Advanced Boiling Water Reactor. In addition, he supported plutonium pit conversion studies, tritium production, and target fabrication evaluations, mixed oxide (MOX) fuel fabrication studies, and a feasibility assessment for converting the FMEF facility at Hanford into a MOX fabrication facility for commercial reactor fuel. Mr. Carrell also provided lead technical support for water and steam utility option studies in the 200 and 300 Areas at Hanford, supported X-ray examination of plutonium storage containers at the Plutonium Finishing Plant (PFP), and participated in a tank integrity assessment, performing remote robotic visual inspection of dangerous waste tanks. He has performed code compliance assessments for nuclear facilities at the Hanford Site, Savannah River; and Idaho Falls. He has prepared SAR chapters on Design Criteria and Facility Description for several DOE facilities. Mr. Carrell participated in pre-Tiger Team inspections of K-25 Site facilities at Oak Ridge, Tennessee.

From 1976 to 1988, Mr. Carrell was a manufacturing engineer and facility nuclear safety representative for Hanford site management and operating contractors, working at the PFP and PUREX. Mr. Carrell coordinated formal safety reviews, provided detailed design review for PFP, including comment resolution for operational health physics, industrial health and safety, fire protection, and criticality engineering. He also performed reviews of various documents, including review and approval of the PFP seismic safety analyses, and supported audit, appraisal, and surveillance programs with independent operational safety assessments. As the manufacturing engineer at PUREX, he provided coordination between engineering, operations, maintenance, and construction forces for project and other plant repair and upgrade work for the PUREX Nuclear Fuel Reprocessing Facility. As the contact engineer at PFP, he reviewed preventive maintenance programs, assessed hoods and glove boxes for corrective action, performed internal safety and criticality audits, assisted in the preparation of the operations budget, and was chairman of the RMA Plutonium Oxide Line ORR Team.

PROFESSIONAL EXPERIENCE SUMMARY

Ray F. Holdaway

Ray F. Holdaway has 34 years of technical and managerial experience in Department of Energy (DOE) programs in Oak Ridge, Tennessee. He is a specialist in systems analysis and the management of technical projects. His experience includes manufacturing equipment development, fabrication engineering, and program management for nuclear weapons production; mechanical systems development, quality assurance management, reliability and systems engineering and management for the gas centrifuge enrichment plant development and design program; systems analysis and project management for U.S. Army and U.S. Navy reliability-centered maintenance programs; management of collaborative research and development programs involving DOE and commercial companies; and management of engineers and analysts evaluating risk associated with packaging and transporting radioactive materials between various DOE sites and the safe operation of selected DOE nuclear and non-nuclear facilities for DOE.

Mr. Holdaway obtained a B.S. degree in engineering science from Tennessee Technological University and has completed graduate studies in engineering mechanics and operations research at the University of Tennessee.

Since 1985, Mr. Holdaway has led the Systems Analysis Group of the Engineering Technology Division of the Oak Ridge National Laboratory (ORNL). In this capacity, he has led engineering analysts in evaluating risks associated with the packaging and transportation of radioactive materials at and between various DOE installations and the safe operation of selected DOE nuclear and non-nuclear facilities. Mr. Holdaway has served as project manager and principal investigator on several reliability-centered maintenance projects for the U.S. Army and U.S. Navy. Also, he currently manages the DOE/ORNL Advanced Machinery Technology Partnerships Program.

From 1978 to 1985, Mr. Holdaway served as Systems Analysis Manager, Program Office, Gas Centrifuge Enrichment Plant Program, Martin Marietta Energy Systems, Inc. During this period, he managed the multicontractor technical staff responsible for operational projections and evaluations for the emerging $4 billion project. He and his staff were responsible for development and use of simulation and analytical models to evaluate the life cycle of the proposed plant in terms of reliability, availability, maintainability, economics, safety, staffing, etc. These analyses were used to establish risk-based priorities for concurrent research, development, engineering, and program management activities. In this capacity, he also managed the integrated system test planning and system analysis support contractor.

From 1963 to 1978, Mr. Holdaway served in several roles at the Oak Ridge Y-12 Plant and the K-25 Site, including machine tool development, machining process engineering, product engineering, assembly engineering, and management of quality assurance.

PROFESSIONAL EXPERIENCE SUMMARY

Calvin D. Jaeger

Calvin D. Jaeger received a B.S. degree in chemistry from Kansas State University, an M.S. degree in chemistry from the University of Texas at El Paso, and a Ph.D. degree in physical chemistry from the University of Texas at Austin. He was awarded a Fulbright-Hays Fellowship to study at the Fritz Haber Institut der Max Planck Gesellschaft in Berlin, Germany.

Dr. Jaeger has worked at Sandia National Laboratories since 1980. For the first 8 years he conducted research on electrochemical and battery systems. Since 1988, he has worked in the Security Systems and Technology Center in the area of nuclear nonproliferation and safeguards. He has been involved in a wide variety of activities with many different organizations. Currently, he is leading Sandia's efforts to support the Department of Defense's Force Protection activities to include developing new approaches for reducing risks. He had overall responsibility for Nuclear Nonproliferation (NP) and Safeguards and Security (S&S) support from Sandia for the U.S. Department of Energy (DOE) Fissile Materials Disposition Program (FMDP) plutonium disposition activities. In support of FMDP, his primary areas of support were to the MOX fuel fabrication and reactor disposition options. He also led the S&S/NP support for the DOE production of tritium using commercial light-water reactors, DOE New Production Reactor Program, DOE Weapons Complex Reconfiguration activities, and DOE Accelerator Production of Tritium Program. Recently, he was the coleader of a joint U.S. and Russian team working on nonproliferation issues for fissile material disposition. The activities in the Russian Federation were primarily focused on ways to help mitigate the threat of nuclear proliferation in Russia. He has also been involved in other areas, including enhancements for airport security, insider tampering and insider threats to DOE security systems and components, protection of alarm communications data using enhanced line security techniques, vulnerability and vital area analysis of nuclear and nonnuclear facilities, development of physical protection requirements and design criteria, and integration of physical protection into major design activities.

Dr. Jaeger is a member of several national associations and working groups involved with nuclear material management, safeguards and security, and nonproliferation. He has published over 75 technical papers and made many presentations at national and international conferences and workshops.

Dr. Jaeger has over 28 years of Army service, both active and reserve. He is a Brigadier General and is currently the deputy commander of a major Army logistical headquarters, the 377th Theater Army Area Command.

PROFESSIONAL EXPERIENCE SUMMARY

Joseph W. Miller

Joseph W. Miller has worked in various capacities in Department of Energy (DOE) programs for 20 years in Oak Ridge, Tennessee. His professional strengths are statistical analysis, cost analysis, and operations research. His experience includes providing cost and statistical analysis relating to the production of nuclear weapons, leading a long-term simulation effort to project the viability of a proposed gas centrifuge (uranium) enrichment plant, modeling the operations of the proposed advanced laser isotope (uranium) enrichment plant, systems analysis efforts on projects for the Departments of Commerce (DoC) and Defense, as well as cost analysis for proposed and planned large scale DOE projects.

Mr. Miller holds a B.A. degree in economics and an M.S. degree in industrial engineering, with emphasis in operations research, and completed all course work for a Ph.D. degree in applied statistics from the University of Alabama.

Since 1994, Mr. Miller has been a member of the Engineering Economics Evaluations Group of the Oak Ridge National Laboratory. In this capacity, he has been involved in providing cost evaluations and analysis on programs for several parts of DOE. His primary emphasis has been for the Fissile Materials Disposition Program.

From 1985 to 1994, Mr. Miller worked at the Oak Ridge Y-12 Plant as a member of the Operations Research Department. In this capacity, he developed simulation models, provided statistical analysis, did classical industrial engineering analyses, helped develop data systems to be used by the DoC manufacturing technology centers, and taught problem solving as a part of the plant training program.

From 1979 to 1985, as a part of the Operations Analysis and Planning organization, Mr. Miller led the effort to model the reliability and operations of the proposed gas centrifuge enrichment plant using a large and detailed simulation model to provide a planning and budget basis for DOE and its contractors. In 1984, he undertook the added responsibility of providing a similar model for the proposed advance vapor isotope separation process.

From 1977 to 1979, Mr. Miller was a staff member in the Operations Analysis Department of the Oak Ridge Y-12 Plant. His efforts there were in the areas of cost and statistical analysis.

PROFESSIONAL EXPERIENCE SUMMARY

Rebecca J. Moses

Rebecca J. Moses has more than 16 years of experience in operations and systems analysis at the Oak Ridge National Laboratory (ORNL). Her project experience includes analysis of the inspection and compliance program of the Office of Pipeline Safety; accident analysis for operations at the gaseous diffusion uranium enrichment plants; system, reliability, and economic analyses and database system development for Department of Defense programs; and development and application of simulation and life cycle models for reliability and maintainability assessments of the gas centrifuge uranium enrichment plant.

Ms. Moses holds a B.A. degree in history from the University of Tennessee at Chattanooga, a B.S. degree in industrial engineering from the University of Tennessee at Knoxville (UTK), and an M.S. degree in industrial engineering with a concentration in operations research also from UTK.

During 1996–1997, Ms. Moses was the principal investigator and project manager for the analysis of the inspection, compliance, and inspection prioritization processes of the Office of Pipeline Safety in the Department of Transportation. The project focused on analysis of the prioritization of inspection activities and the development of a revised risk-based process for ranking pipeline units for inspection for compliance with federal safety regulations.

From 1990 to 1995 she was a member of a team supporting the accident analysis activities for the Gaseous Diffusion Plant Safety Analysis Report Upgrade Program. In this assignment, she led frequency analysis efforts to estimate the occurrence of postulated accident events at the Paducah and Portsmouth Gaseous Diffusion Plants. Her responsibilities included performing fault tree analyses of accidents involving release of uranium hexafluoride during feed operations as well as leading teams of subcontractors conducting similar fault tree analyses and support systems analyses for feed, withdrawal, and transfer processes. Ms. Moses conducted preliminary hazards analyses and hazards and operability studies for withdrawal and sample analysis operations and analyzed trends in radiation readings to determine locations in the enrichment cascades at Portsmouth likely to have significant deposits of UF_6.

Ms. Moses supported several projects for the U.S. Navy and Army from 1985 to 1993. Early in this period, she was a reliability analyst and database manager responsible for the review of operational experience of turbine generators in a system study for the Naval Sea Systems Command. She was a principal analyst in a study sponsored by the Army Materiel Command to determine the effectiveness of reliability-centered maintenance in the Army. She served as the technical lead in a project for the Army Aviation Systems Command to design a reliability-centered maintenance analysis system that included design of the relational database and engineering analysis tools. In 1993 Ms. Moses assisted the ORNL development of the Future Armored Resupply Vehicle modules for the Army by developing cost data and performing economic analyses of various design options for the artillery round upload, identification, and delivery subsystems.

From 1981 to 1985, Ms. Moses was an analyst in the Gas Centrifuge Enrichment Plant Program. She was responsible for developing simulation models to support reliability and maintainability assessments of candidate centrifuge machine designs deployed according to various installation schedules and plant configurations. During this time, her work involved evaluating alternative repair policies for impact on expected centrifuge operations and life cycle cost and participating in the development of a centrifuge replacement parts model. The application of these models supported cost analyses and design and logistics support decision-making.

PROFESSIONAL EXPERIENCE SUMMARY

John D. Sease

John D. Sease has over 35 years of experience in various development and management roles in waste management, nuclear energy, and manufacturing. His experience includes both government and private industry with over 20 years of this experience involved with the design and operation of Department of Energy (DOE) and commercial facilities for processing nuclear and other materials. He has been issued 13 patents associated with equipment and processes for processing nuclear materials and has prepared over 60 technical publications. Mr. Sease holds B.S. and M.S. degrees in ceramic engineering from Clemson University and is a licensed professional engineer.

Currently, Mr. Sease is a research reactor nuclear fuel specialist responsible for the procurement and surveillance of fuel elements and control rods for the High Flux Isotope Reactor (HFIR) and the waste management engineering coordinator for HFIR. Mr. Sease served in the Powder Metallurgy and Fuel Cycle Technology Groups in the Metals and Ceramics Division of Oak Ridge National Laboratory (ORNL) from 1960–1976. He fabricated uranium/plutonium oxide and carbide compacts and pyrolytic carbon-coated plutonium oxide microsphere fuels for irradiation testing in a variety of experimental reactors.

He developed a flowsheet for preparing a ceramic oxide powder with ^{233}U and highly enriched uranium that included the use of a microwave drying process and a unique technique for stabilizing UO_2 powder from oxidation. This powder process was used to make over 800 kg of $^{233}UO_2$ powder to exact quality standards for a Naval Reactors Program. Mr. Sease has been responsible for the design, procurement, and operation of several glove box lines for processing plutonium and has developed a number of patented processes for fabricating nuclear fuels.

Mr. Sease has been associated with environmental and waste management activities for over 20 years. As Section and Program Manager in the Operations Division at ORNL from 1979 through 1983, he was responsible for radioactive waste operations at ORNL. In this position, he directed the $20M/year operations of ORNL gaseous, liquid, and solid waste facilities and remedial actions on previously used waste disposal sites. Mr. Sease served as a member of the committee that established the transuranic (TRU) waste acceptance criteria for the Waste Isolation Pilot Plant (WIPP) and served as chairman of a DOE advisory committee on defense waste operations at DOE sites. He directed DOE studies for waste minimization in commercial fuel fabrication plants and for buried and difficult-to-certify TRU waste. He served as office director and a consultant for several commercial firms, including Bechtel National, in the environmental and waste management field for a total of 5 years before coming to Martin Marietta Energy Systems Central Waste Management Division in June 1991.

As a member of the Chemical Technology Division at ORNL, Mr. Sease was one of the initial members of the department formed to develop processes and equipment for aqueous reprocessing of spent fuel for the Liquid-Metal Fast Breeder Reactor. He served as the task leader for the robotics and nitrate-to-oxide conversion tasks. He served as the program manager of an ORNL study on dry cask storage of spent fuel rods stored at the West Valley Reprocessing plant.

As a member of Union Carbide -Electronics Division, Mr. Sease served as the process engineering manager for manufacturing tantalum and monolithic ceramic electronic capacitors for a total of 5 years up to 1986. This experience included management of process engineering at multiple plant sites with responsibility for the introduction of new processes, materials, and equipment into production and support for day-to-day production operation. Processes included high-temperature vacuum processing, rotary and pusher-type continuous ceramic kilns, electrochemical and electroplating, screen printing, and ceramic powder processing.

PROFESSIONAL EXPERIENCE SUMMARY

Alfred A. Strasser

Alfred A. Strasser has 49 years of industrial experience, 43 of which are in nuclear fuel and reactor technology. Thirteen years of his career were dedicated full time to plutonium fuels, and he subsequently has spent several years consulting in that area. Mr. Strasser's activities in fuels technology included the design, development, fabrication, quality assurance, irradiation testing, post-irradiation examination, and evaluation of fuel performance. He also has experience in nuclear, thermal-hydraulic, and systems design; fuel cycle economics; and fabrication costs necessary for a complete understanding of the fuel cycle. Mr. Strasser is the author of over 70 publications.

Mr. Strasser received a B.S. degree in metallurgical engineering from Purdue University and an M.S. degree in metallurgical engineering from Stevens Institute of Technology. He completed work toward a Ph.D. degree at Ohio State University and New York University.

Since 1995, Mr. Strasser has consulted on a number of projects for EPRI and U.S. and foreign utilities. From 1972 to 1994, Mr. Strasser was president of the Eastern Division of S. M. Stoller Corporation, where he evaluated uranium and plutonium fuel and core components and in-reactor performance, performed quality assurance audits of fuel design and fabrication, and conducted post-irradiation examinations in the reactor pool and hot cells. From 1954 to 1972, Mr. Strasser managed the Plutonium Fuels Department of United Nuclear Corporation. In this position, he was responsible for the materials design and specifications of all reactor components and fuel cycle core analyses.

PROFESSIONAL EXPERIENCE SUMMARY

Marion L. Thompson

Marion L. Thompson has 37 years of technical and management experience with the General Electric Company (GE) in nuclear safety, fuel fabrication, research and development of fuel materials and processes, chemical processing, and the GE-owned, Nuclear Regulatory Commission (NRC)-licensed, plutonium facility startup, operation, and decommissioning. His expertise includes technical and economic evaluation of fuel cycles and fuel processing systems and application of systems engineering to achieve quality production and reliability. He performed fuel cycle assessment and economic evaluations including cost comparisons of plutonium and enriched uranium reactor cores. He has extensive experience in preparation of proposals, specifications, and procedures, and in program management.

Mr. Thompson was a major participant in industry–national laboratory task forces that interfaced with the National Academy of Sciences on actinide recycling in advanced fast reactors and on utilization of excess weapons plutonium. He is the author of several publications and has participated in numerous presentations.

After early retirement from GE in 1994, Mr. Thompson was a principal investigator and author of a report on the economic potential of plutonium fuel compared to uranium fuel in work performed in 1995 for the Electric Power Research Institute. He provided engineering consultation in 1996 to the Lockheed Martin Company on transuranic and other waste processing at the Savannah River Site and at the Idaho National Engineering and Environmental Laboratory. In 1997, he has consulted with Los Alamos and Oak Ridge National Laboratories on mixed-oxide fuel in connection with the disposition of excess weapons-usable plutonium.

Mr. Thompson received a B.S. degree in materials science engineering from California State University, San Jose. He received numerous certificates of GE advanced technical and management courses. He is a certified manufacturing engineer/technologist and a member of Robotics International of the Society of Manufacturing Engineers. At GE he received general manager's awards for his contributions to plutonium laboratory decommissioning, actinide recycle activities, and excess weapons plutonium disposition studies.

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Appendix C
DATA COLLECTION FORMS

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Appendix C. DATA COLLECTION FORMS

This appendix contains three exhibits:

Exhibit C-1	MOX LA Fuel Facility Task Data Sheet
Exhibit C-2	List of Attributes
Exhibit C-3	List of Project Tasks

Exhibit C-1, MOX LA Fuel Facility Task Data, is a data sheet used by the Site Evaluation Team (SET) as a checklist during the facility tour and work sessions with the site personnel. The purpose for using this checklist was to ensure that each task was fully discussed and pertinent data was collected for review and analysis.

Exhibit C-2, List of Attributes, is a listing of 28 attributes used by SET to characterize the suitability of the candidate host facilities for the lead assembly (LA) project. The 28 attributes are grouped into 5 categories.

Exhibit C-3, List of Project Tasks, identifies the milestones, subprojects, and 103 tasks that were used to define the effort, fiscal resources, and time required to conduct the LA project at each of the candidate host sites. The list also identifies which project phase—preoperational phase, operational phase, standby phase, or decontamination and decommissioning phase—each of the tasks is defined to support.

EXHIBIT C-1. MOX LA FUEL FACILITY TASK DATA SHEET

MOX LA Fuel Facility Task Data

Site Option: **SET Member:**

Task ID **Task Name**

Asmt Summary:

Assessment:

Effort Req Summary:

Effort Required:

	Low Estimate	Most Likely Estimate	High Estimate
Duration of Task (weeks)			

Task Resources:

Materials/Supplies Needed:

Fixed Cost Items:

Further Comments:

EXHIBIT C-2. LIST OF ATTRIBUTES

1. PROJECT-LEVEL ATTRIBUTES

   Facility and mission compatibility
   Cost and cost risk
   Schedule and schedule risk
   Quality assurance program

2. OPERATIONAL ATTRIBUTES

   Production-processing approach
   MOX fuel fabrication experience
   Prototypic process equipment
   Batch size flexibility and analytical optimization
   Characteristics of proposed facilities for processing

3. SAFETY-RELATED ATTRIBUTES

   NEPA compliance
   Safety bases
   Operational readiness review
   DOE Order compliance
   Compliance with plutonium-processing and -handling facility design criteria

4. SAFEGUARDS AND SECURITY-RELATED ATTRIBUTES

   Physical protection
   Material control and accountability
   Vulnerability assessment and site safeguards and security plans
   Radiological sabotage potential
   Access by foreign nationals and uncleared personnel
   Special nuclear material storage
   Other safeguards and security characteristics

5. OTHER ATTRIBUTES

   Site infrastructure available to support the LA project
   Off-site transportation
   On-site transportation
   Formal design methodology
   Waste management
   Radiation protection
   Decontamination and decommissioning

EXHIBIT C-3. LIST OF PROJECT TASKS

Index	Type	Phase	Description
1	Milestone	Milestone	Program Decision: Select MOX fuel fabrication vendor
2	Milestone	Milestone	Program Decision: Select MOX LA fabrication site
3	Subproject 1	Subproject	Project Management
4	Task 1	Preoperational	Manage preoperational phase
5	Task 2	Operational	Manage operational phase
6	Task 3	Standby	Manage standby phase
7	Task 4	Preoperational	Develop plan for facilities upgrades
8	Task 5	Preoperational	Develop fabrication process plan
9	Task 6	Preoperational	Develop MOX LA fabrication plan
10	Task 7	Operational	Process support, operational phase
11	Task 8	Standby	Process support, standby phase
12	Subproject 2	Subproject	Infrastructure Upgrade/Modifications
13	Task 9	Preoperational	Verify NEPA documentation
14	Task 10	Preoperational	Modify site agreements
15	Task 11	Preoperational	Modify site environmental permits
16	Task 12	Preoperational	Develop plan for S&S upgrades
17	Task 13	Preoperational	Upgrade physical security (if necessary)
18	Task 14	Preoperational	Upgrade MC&A (if necessary)
19	Task 15	Preoperational	Upgrade SST handling (if necessary)
20	Task 16	Preoperational	Upgrade other S&S features (if necessary)
21	Task 17	Preoperational	Complete site S&S plan
22	Task 18	Preoperational	Validate/Test S&S systems
23	Task 19	Preoperational	Modify emergency response plan
24	Task 20	Preoperational	Upgrade control center
25	Task 21	Preoperational	Upgrade fire department
26	Task 22	Preoperational	Upgrade medical department
27	Task 23	Preoperational	Upgrade/Modify waste management process
28	Task 24	Preoperational	Upgrade intrasite transportation
29	Subproject 3	Subproject	Vault(s) modifications
30	Task 25	Preoperational	Design modifications
31	Task 26	Preoperational	Make premodification preparations
32	Task 27	Preoperational	Procure materials
33	Task 28	Preoperational	Construction/Installation
34	Task 29	Preoperational	Modify SAR
35	Task 30	Preoperational	Modify environmental permits
36	Subproject 4	Subproject	Powder/Pellet/Rod Fabrication Facility Modifications
37	Task 31	Preoperational	Design modifications
38	Task 32	Preoperational	Make premodification preparations
39	Task 33	Preoperational	Procure materials

Index	Type	Phase	Description
40	Task 34	Preoperational	Construction/Installation
41	Task 35	Preoperational	Upgrade HP instrumentation
42	Task 36	Preoperational	Modify SAR
43	Task 37	Preoperational	Modify environmental permits
44	Subproject 5	Subproject	Bundle Assembly Facility Modifications
45	Task 38	Preoperational	Design modifications
46	Task 39	Preoperational	Make premodification preparations
47	Task 40	Preoperational	Procure materials
48	Task 41	Preoperational	Construction/Installation
49	Task 42	Preoperational	Modify SAR
50	Task 43	Preoperational	Modify environmental permits
51	Subproject 6	Subproject	Bundle Storage Facility Modifications
52	Task 44	Preoperational	Design modifications
53	Task 45	Preoperational	Make premodification preparations
54	Task 46	Preoperational	Procure materials
55	Task 47	Preoperational	Construction/Installation
56	Task 48	Preoperational	Modify SAR
57	Task 49	Preoperational	Modify environmental permits
58	Subproject 7	Subproject	Analytical Facilities Modifications
59	Task 50	Preoperational	Design modifications
60	Task 51	Preoperational	Make premodification preparations
61	Task 52	Preoperational	Specify equipment
62	Task 53	Preoperational	Procure materials/equipment
63	Task 54	Preoperational	Construction/Installation
64	Task 55	Preoperational	Modify SAR
65	Task 56	Preoperational	Modify environmental permits
66	Subproject 8	Subproject	Powder/Pellet/Rod Process Equipment
67	Task 57	Preoperational	Design PPR process line
68	Task 58	Preoperational	Specify/Design PPR equipment
69	Task 59	Preoperational	Specify accountability system
70	Task 60	Preoperational	Procure process/accountability equipment
71	Task 61	Preoperational	Install PPR and accountability equipment
72	Task 62	Preoperational	Unit test process equipment
73	Subproject 9	Subproject	Bundle Assembly Process Equipment
74	Task 63	Preoperational	Design assembly process line
75	Task 64	Preoperational	Specify/Design assembly equipment
76	Task 65	Preoperational	Procure process equipment
77	Task 66	Preoperational	Install process equipment
78	Task 67	Preoperational	Unit test process equipment
79	Subproject 10	Subproject	Fabrication Operations - Vault Storage
80	Task 68	Preoperational	Develop operating procedures
81	Task 69	Preoperational	Conduct operational readiness review
82	Task 70	Operational	Receive Pu shipments and store Pu oxide

Index	Type	Phase	Description
83	Task 71	Operational	Transfer Pu oxide to PPR processing
84	Task 72	Operational	Intrasite transportation (if needed)
85	Subproject 11	Subproject	Fabrication Operations - Powder/Pellets/Rods
86	Task 73	Preoperational	Develop operating procedures
87	Task 74	Preoperational	Procure DU oxide
88	Task 75	Preoperational	Procure rod hardware
89	Task 76	Preoperational	Conduct preoperational readiness review
90	Task 77	Preoperational	Perform analytical qualification
91	Task 78	Operational	Conduct analytical operations
92	Task 79	Operational	Cold startup
93	Task 80	Operational	Conduct operational readiness review
94	Task 81	Operational	Hot startup operations
95	Task 82	Operational	Produce first qualified rod
96	Task 83	Operational	Rod fabrication operations
97	Task 84	Operational	Waste management operations
98	Task 85	Operational	Intrasite transportation (if needed)
99	Milestone	Milestone	Program Target: First Qualified Rod Fabricated
100	Milestone	Milestone	Program Target: Complete Rod Fabrication Operations
101	Subproject 12	Subproject	Fabrication Operations - Bundle Assembly
102	Task 86	Preoperational	Develop operating procedures
103	Task 87	Preoperational	Procure bundle hardware
104	Task 88	Preoperational	Conduct operational readiness review
105	Task 89	Operational	Hot startup operations
106	Task 90	Operational	Bundle assembly operations
107	Task 91	Operational	Intrasite transportation (if needed)
108	Milestone	Milestone	Program Target: Bundle Assembly Operations Complete
109	Subproject 13	Subproject	Fabrication Operations - Rod/Bundle Storage
110	Task 92	Preoperational	Develop operating procedures
111	Task 93	Preoperational	Conduct operational readiness review
112	Task 94	Operational	Store rods and bundles
113	Task 95	Operational	Ship bundles
114	Subproject 14	Subproject	Facilities Standby
115	Task 96	Standby	Develop standby plan
116	Task 97	Standby	Retain process qualifications
117	Task 98	Standby	Perform surveillance activities
118	Subproject 15	Subproject	Decontaminate & Decommission
119	Task 99	D&D	Develop D&D plan
120	Task 100	D&D	Ship scrap Pu and DU for disposition
121	Task 101	D&D	D&D PPR processing facility
122	Task 102	D&D	Dispose of uncontaminated equipment
123	Task 103	D&D	Dispose of waste

Appendix D
SRS H-CANYON OPTION SCHEDULE

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Appendix D. SRS H-CANYON OPTION SCHEDULE

This appendix contains summary-level schedule and effort data for the Savannah River Site (SRS) option for fabricating MOX fuel for the proposed lead assembly project. Data for the SRS H-Canyon option were produced from the standardized project model developed by the Site Evaluation Team to collect, analyze, and display data for each of the candidate options. Cost data from the project model are displayed in Chaps. 2 and 3.

The schedule for each of the milestones, subprojects, and individual tasks is depicted graphically in a Gantt chart, which displays durations and constraints for the activities and events.

Effort is identified as "FTE-Work" and is tabulated for each task and summarized for each subproject. FTE-Work is interpreted as the average number of full-time-equivalent (FTE) persons of all classifications who work for the duration indicated by the schedule bar.

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ID	Task Name	FTE-Work
1	Program Decision: Select MOX fuel fabrication vendor	0 wks
2	Program Decision: Select MOX LA fabrication site	0 wks
3	**Project Management**	**5,595.85 wks**
4	Manage preoperational phase	1,243.75 wk
5	Manage operational phase	2,250 wks
6	Manage standby phase	900.9 wks
7	Develop plan for facilities upgrades	100 wks
8	Develop fabrication process plan	100 wks
9	Develop MOX LA fabrication plan	501 wks
10	Process support, operational phase	300 wks
11	Process support, standby phase	200.2 wks
12	**Infrastructure Upgrade/Modifications**	**360.17 wks**
13	Verify NEPA documentation	11.8 wks
14	Modify site agreements	0 wks
15	Modify site environmental permits	21.59 wks
16	Develop plan for S&S upgrades	50.4 wks
17	Upgrade physical security (if necessary)	78.2 wks
18	Upgrade MC&A (if necessary)	48.38 wks
19	Upgrade SST handling (if necessary)	6 wks
20	Upgrade other S&S features (if necessary)	3 wks
21	Complete site S&S plan	116 wks
22	Validate/Test S&S systems	16.8 wks
23	Modify emergency response plan	6 wks
24	Upgrade control center	0 wks
25	Upgrade fire department	0 wks
26	Upgrade medical department	0 wks

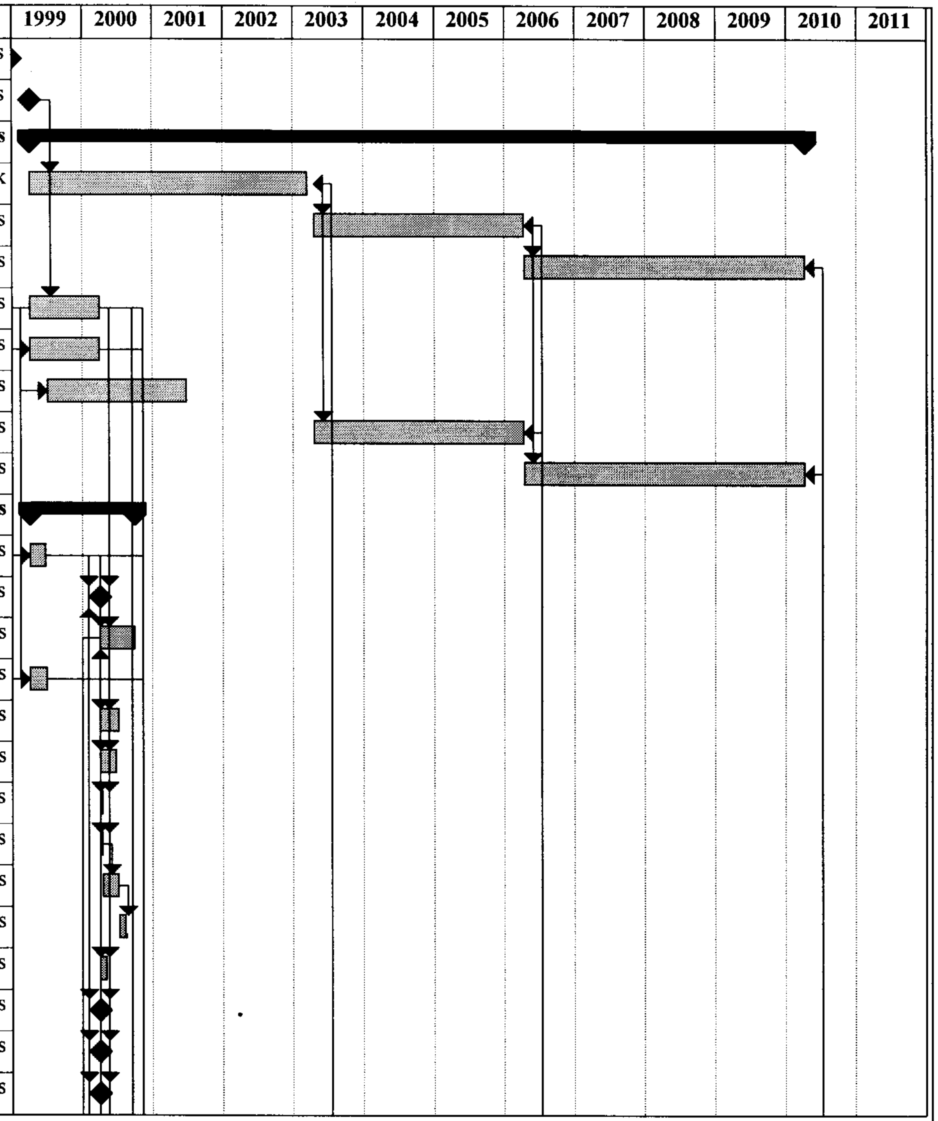

Fig. D-1. MOX fuel lead assembly site characterization: SRS H-Canyon option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
27	Upgrade/Modify waste management process	0 wks
28	Upgrade intrasite transportation	2 wks
29	**Vault(s) Modifications**	**192.9 wks**
30	Design modifications	61.6 wks
31	Make premodification preparations	26.1 wks
32	Procure materials	7.6 wks
33	Construction/Installation	82.6 wks
34	Modify SAR	15 wks
35	Modify environmental permits	0 wks
36	**Powder/Pellet/Rod Fabrication Facility Modifications**	**784.75 wks**
37	Design modifications	200.8 wks
38	Make premodification preparations	128 wks
39	Procure materials	8.85 wks
40	Construction/Installation	198.4 wks
41	Upgrade HP instrumentation	211.2 wks
42	Modify SAR	37.5 wks
43	Modify environmental permits	0 wks
44	**Bundle Assembly Facility Modifications**	**92.98 wks**
45	Design modifications	25.2 wks
46	Make premodification preparations	0 wks
47	Procure materials	9.45 wks
48	Construction/Installation	50.8 wks
49	Modify SAR	7.53 wks
50	Modify environmental permits	0 wks
51	**Bundle Storage Facility Modifications**	**80.43 wks**
52	Design modifications	11.6 wks

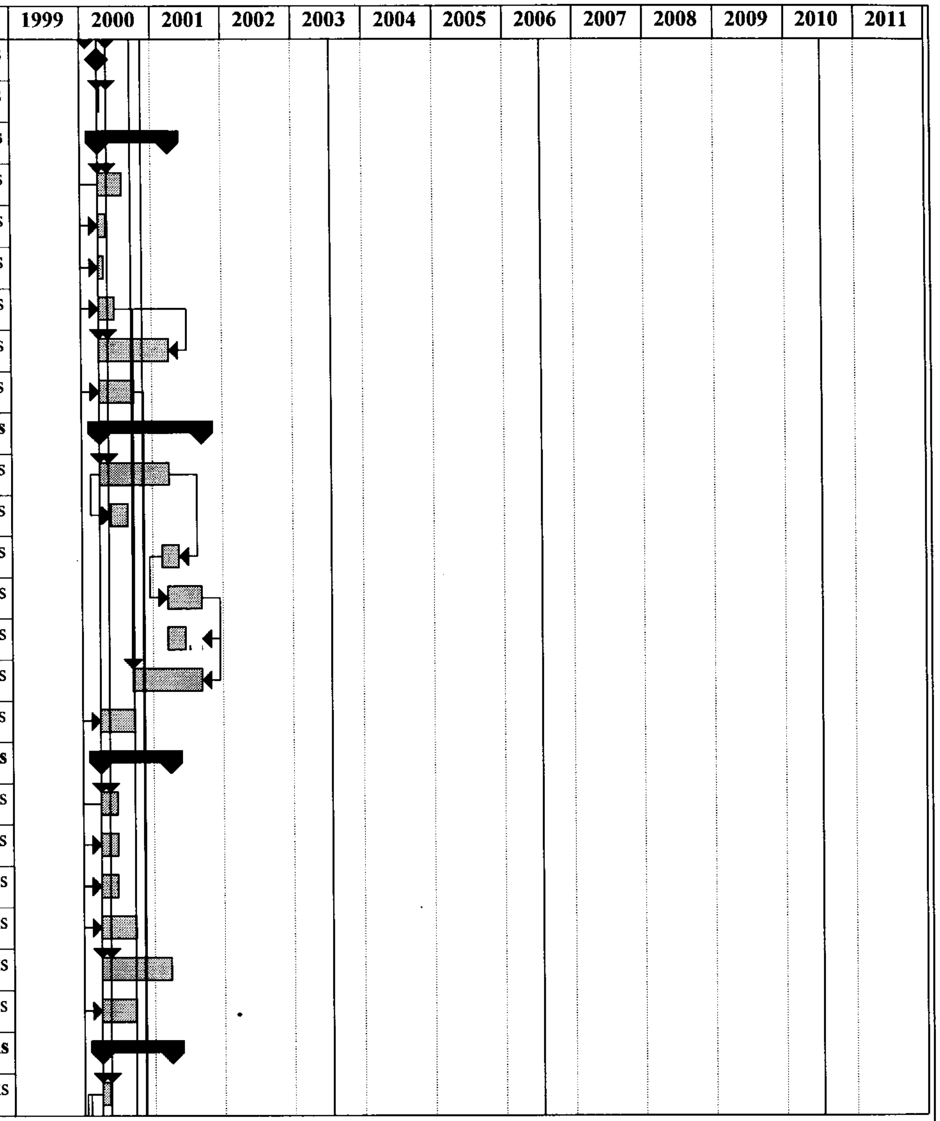

Fig. D-1. MOX fuel lead assembly site characterization: SRS H-Canyon option schedule.

FTE = full time equivalent

Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
53	Make premodification preparations	31.2 wks
54	Procure materials	2.8 wks
55	Construction/Installation	27.3 wks
56	Modify SAR	7.53 wks
57	Modify environmental permits	0 wks
58	**Analytical Facilities Modifications**	**494.34 wks**
59	Design modifications	12.6 wks
60	Make premodification preparations	25.2 wks
61	Specify equipment	25.2 wks
62	Procure materials/equipment	11.34 wks
63	Construction/Installation	412.5 wks
64	Modify SAR	7.5 wks
65	Modify environmental permits	0 wks
66	**Powder/Pellet/Rod Process Equipment**	**1,508.1 wk**
67	Design PPR process line	228.6 wks
68	Specify/Design PPR equipment	101.6 wks
69	Specify accountability system	14.5 wks
70	Procure process/accountability equipment	100 wks
71	Install PPR and accountability equipment	950 wks
72	Unit test process equipment	113.4 wks
73	**Bundle Assembly Process Equipment**	**72.15 wks**
74	Design assembly process line	18.9 wks
75	Specify/Design assembly equipment	9.45 wks
76	Procure process equipment	9.45 wks
77	Install process equipment	25.2 wks
78	Unit test process equipment	9.15 wks

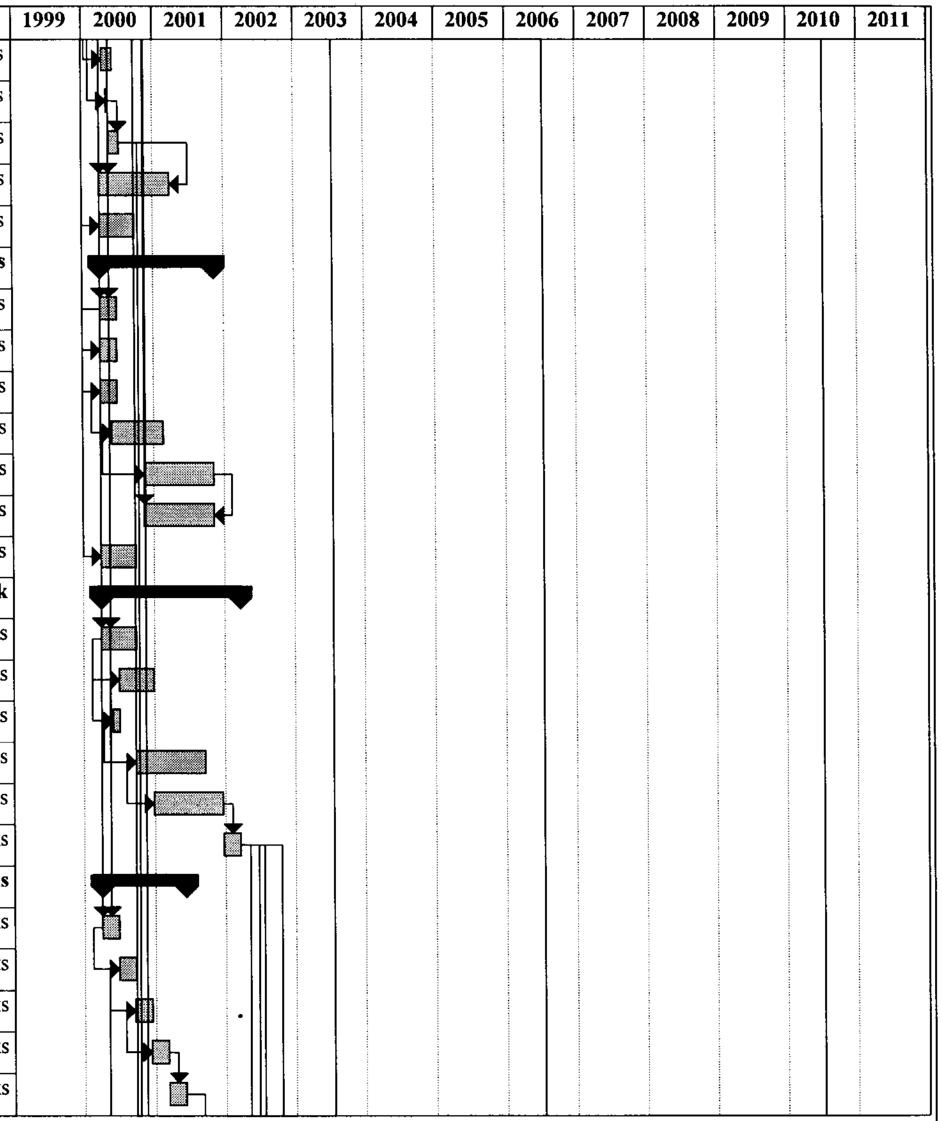

Fig. D-1. MOX fuel lead assembly site characterization: SRS H-Canyon option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
79	**Fabrication Operations - Vault Storage**	**271.06 wks**
80	Develop operating procedures	81.2 wks
81	Conduct operational readiness review	24.8 wks
82	Receive Pu shipments and store Pu oxide	120.06 wks
83	Transfer Pu oxide to PPR processing	45 wks
84	Intrasite transportation (if needed)	0 wks
85	**Fabrication Operations - Powder/Pellets/Rods**	**7,729.61 wks**
86	Develop operating procedures	1,400 wks
87	Procure DU oxide	3.78 wks
88	Procure rod hardware	3.78 wks
89	Conduct preoperational readiness review	61.5 wks
90	Perform analytical qualification	64.05 wks
91	Conduct analytical operations	1,035.1 wk
92	Cold startup	471.2 wks
93	Conduct operational readiness review	0 wks
94	Hot startup operations	340.2 wks
95	Produce first qualified rod	0 wks
96	Rod fabrication operations	4,350 wks
97	Waste management operations	0 wks
98	Intrasite transportation (if needed)	0 wks
99	Program Target: First Qualified Rod Fabricated	0 wks
100	Program Target: Complete Rod Fabrication Operations	0 wks
101	**Fabrication Operations - Bundle Assembly**	**348.59 wks**
102	Develop operating procedures	39.65 wks
103	Procure bundle hardware	12.48 wks
104	Conduct operational readiness review	14.76 wks

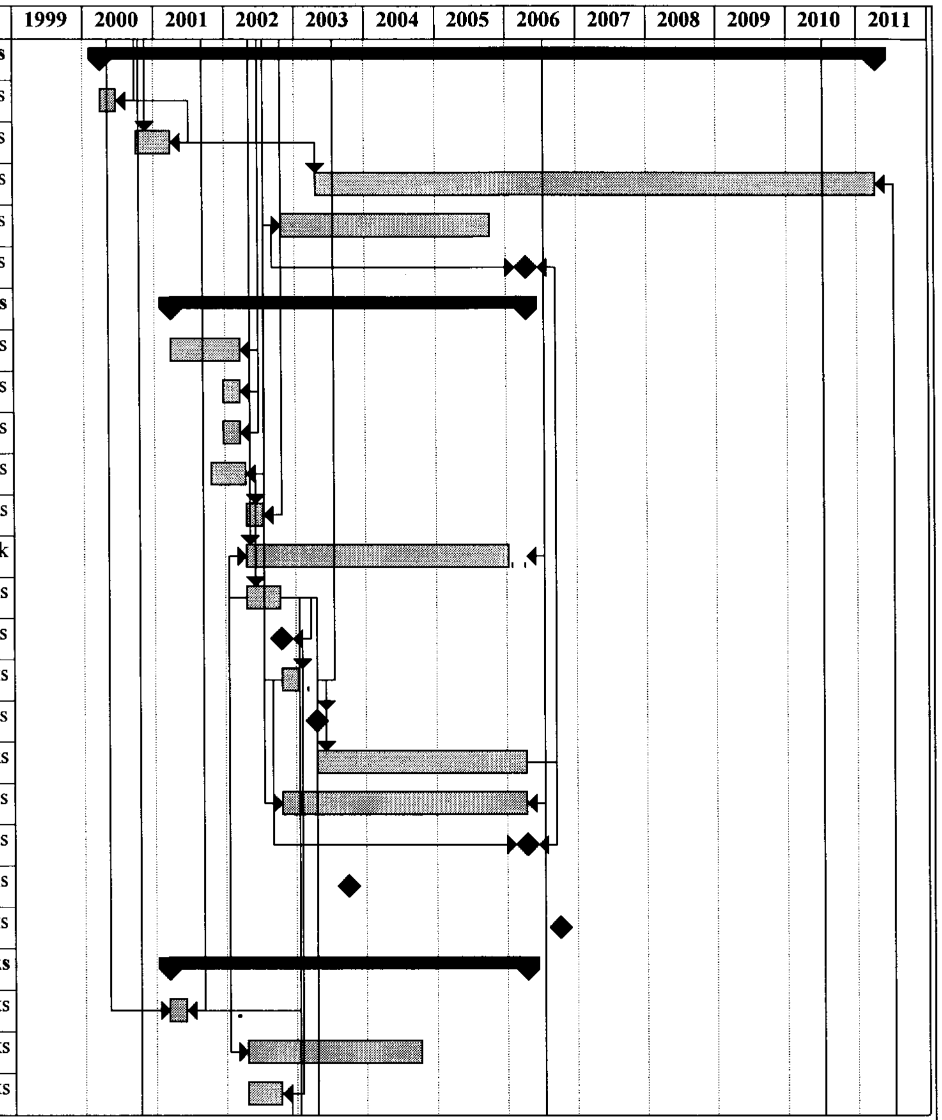

Fig. D-1. MOX fuel lead assembly site characterization: SRS H-Canyon option schedule.

FTE = full time equivalent

Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
105	Hot startup operations	56.7 wks
106	Bundle assembly operations	225 wks
107	Intrasite transportation (if needed)	0 wks
108	Program Target: Bundle Assembly Operations Complete	0 wks
109	**Fabrication Operations - Rod/Bundle Storage**	**96.79 wks**
110	Develop operating procedures	11.6 wks
111	Conduct operational readiness review	10.16 wks
112	Store rods and bundles	60.03 wks
113	Ship bundles	15 wks
114	**Facilities Standby**	**1,253.44 wk**
115	Develop standby plan	12.2 wks
116	Retain process qualifications	1,241.24 wk
117	Perform surveillance activities	0 wks
118	**Decontaminate & Decommission**	**479 wks**
119	Develop D&D plan	100 wks
120	Ship scrap Pu and DU for disposition	10 wks
121	D&D PPR processing facility	369 wks
122	Dispose of uncontaminated equipment	0 wks
123	Dispose of waste	0 wks

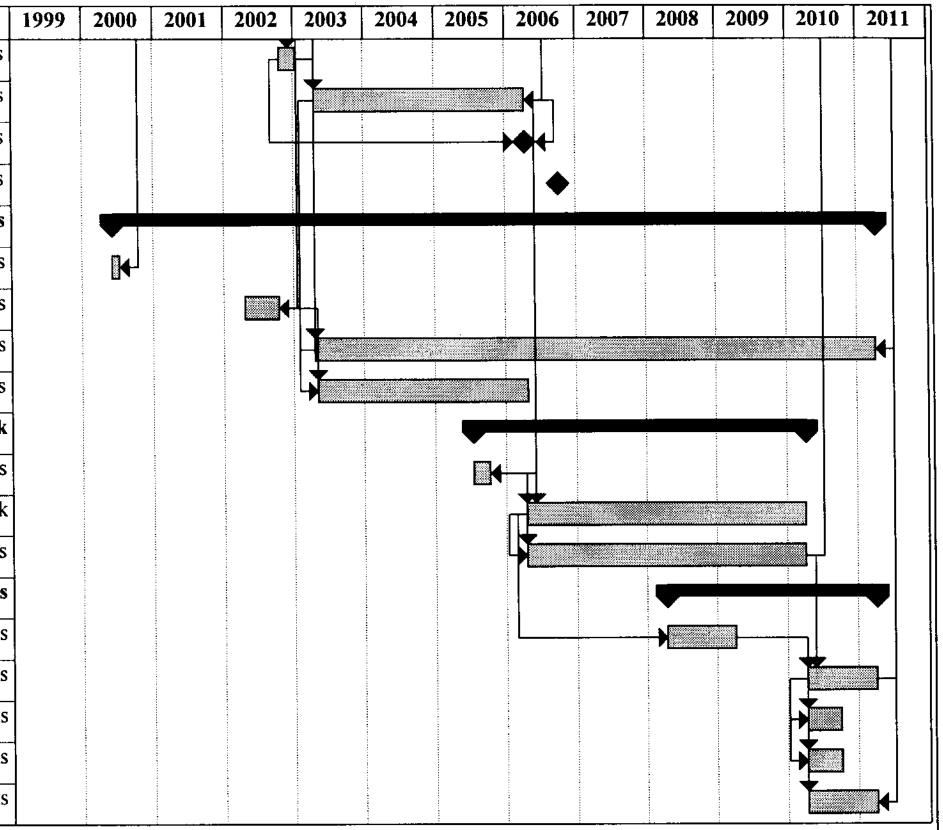

Fig. D-1. MOX fuel lead assembly site characterization: SRS H-Canyon option schedule.

FTE = full time equivalent

Timescale is in fiscal years beginning October 1998

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Appendix E
ANL-W FMF OPTION SCHEDULE

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Appendix E. ANL-W FMF OPTION SCHEDULE

This appendix contains summary-level schedule and effort data for the Argonne National Laboratory-West (ANL-W) option for fabricating MOX fuel for the proposed lead assembly project. Data for the ANL-W option were produced from the standardized project model developed by the Site Evaluation Team to collect, analyze, and display data for each of the candidate options. Cost data from the project model are displayed in Chaps. 2 and 4.

The schedule for each of the milestones, subprojects, and individual tasks is depicted graphically in a Gantt chart, which displays durations and constraints for the activities and events.

Effort is identified as "FTE-Work" and is tabulated for each task and summarized for each subproject. FTE-Work is interpreted as the average number of full-time-equivalent (FTE) persons of all classifications who work for the duration indicated by the schedule bar.

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ID	Task Name	FTE-Work
1	Program Decision: Select MOX fuel fabrication vendor	0 wks
2	Program Decision: Select MOX LA fabrication site	0 wks
3	**Project Management**	**4,206.26 wks**
4	Manage preoperational phase	1,094.5 wk
5	Manage operational phase	1,350 wks
6	Manage standby phase	560.56 wks
7	Develop plan for facilities upgrades	100 wks
8	Develop fabrication process plan	100 wks
9	Develop MOX LA fabrication plan	501 wks
10	Process support, operational phase	300 wks
11	Process support, standby phase	200.2 wks
12	**Infrastructure Upgrade/Modifications**	**144.75 wks**
13	Verify NEPA documentation	12.6 wks
14	Modify site agreements	12.6 wks
15	Modify site environmental permits	12.55 wks
16	Develop plan for S&S upgrades	19.8 wks
17	Upgrade physical security (if necessary)	17.1 wks
18	Upgrade MC&A (if necessary)	26.4 wks
19	Upgrade SST handling (if necessary)	0 wks
20	Upgrade other S&S features (if necessary)	3 wks
21	Complete site S&S plan	11.7 wks
22	Validate/Test S&S systems	14.4 wks
23	Modify emergency response plan	12.6 wks
24	Upgrade control center	0 wks
25	Upgrade fire department	0 wks
26	Upgrade medical department	0 wks

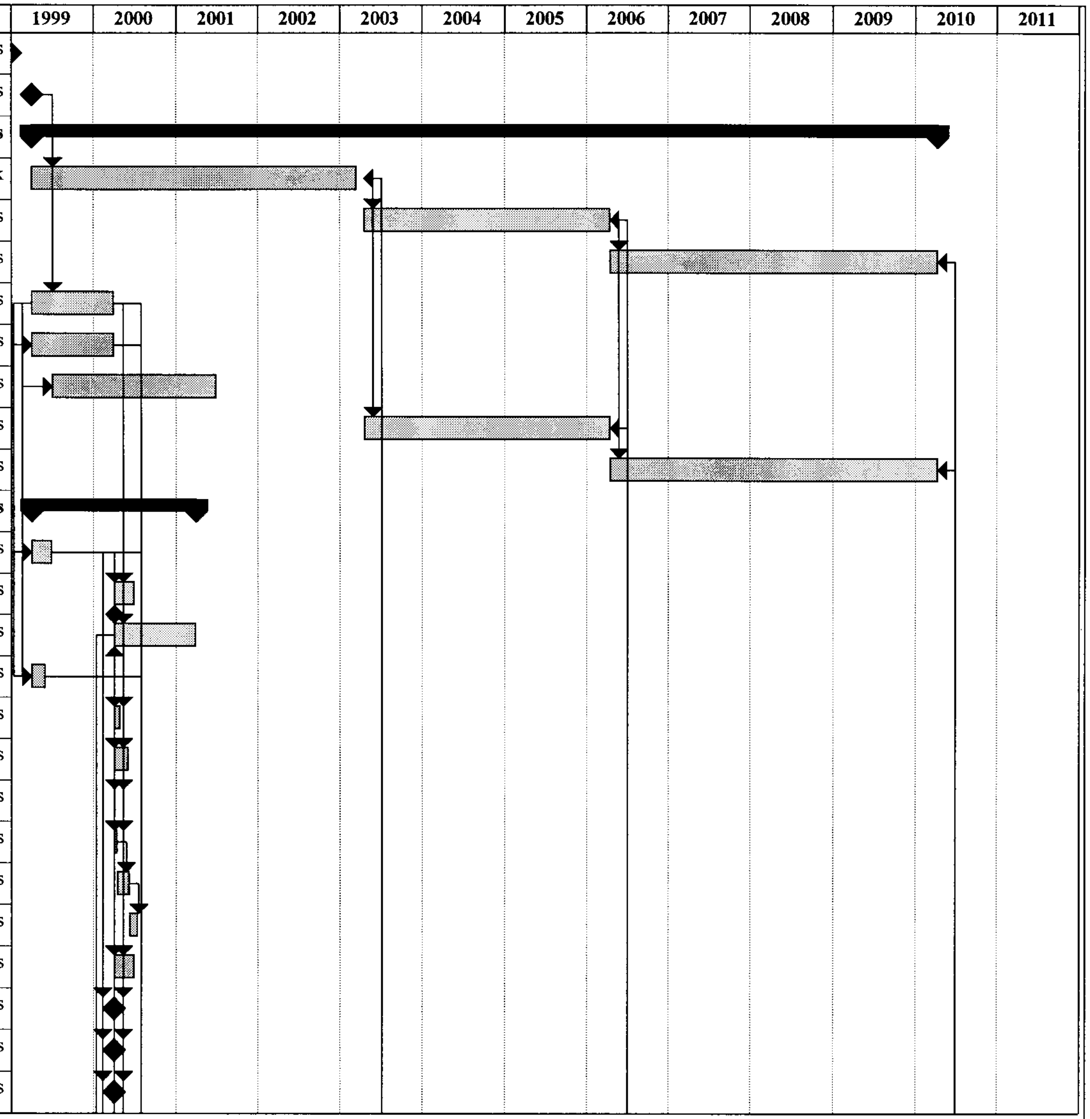

Fig. E-1. MOX fuel lead assembly site characterization: ANL-W FMF option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
27	Upgrade/Modify waste management process	0 wks
28	Upgrade intrasite transportation	2 wks
29	**Vault(s) Modifications**	**83.76 wks**
30	Design modifications	17.4 wks
31	Make premodification preparations	34.8 wks
32	Procure materials	6.96 wks
33	Construction/Installation	12 wks
34	Modify SAR	12.6 wks
35	Modify environmental permits	0 wks
36	**Powder/Pellet/Rod Fabrication Facility Modifications**	**680.78 wks**
37	Design modifications	301.2 wks
38	Make premodification preparations	62.4 wks
39	Procure materials	12.3 wks
40	Construction/Installation	172.2 wks
41	Upgrade HP instrumentation	7.68 wks
42	Modify SAR	125 wks
43	Modify environmental permits	0 wks
44	**Bundle Assembly Facility Modifications**	**100.5 wks**
45	Design modifications	12.6 wks
46	Make premodification preparations	12.6 wks
47	Procure materials	0 wks
48	Construction/Installation	0 wks
49	Modify SAR	75.3 wks
50	Modify environmental permits	0 wks
51	**Bundle Storage Facility Modifications**	**67.24 wks**
52	Design modifications	7.6 wks

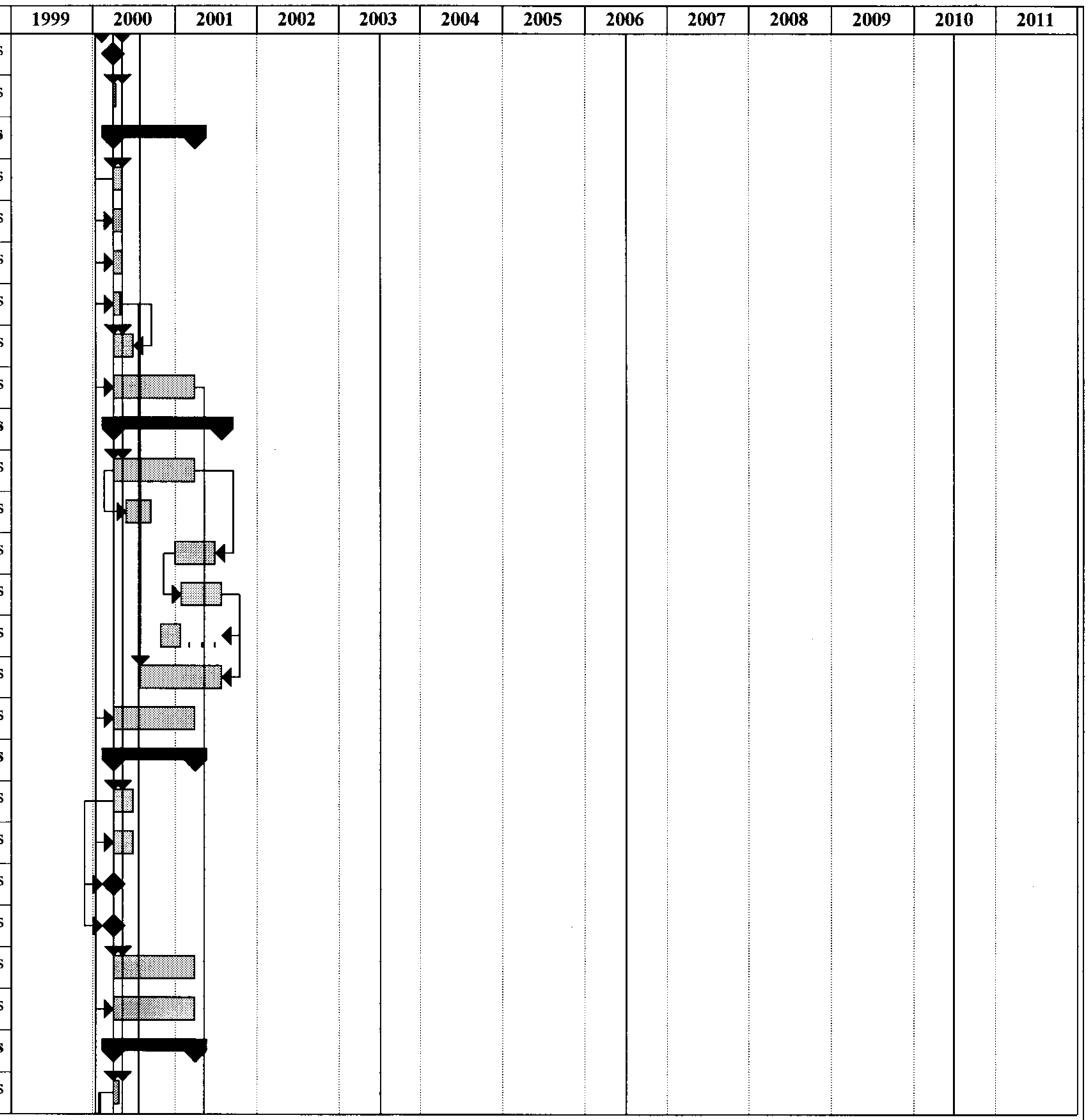

Fig. E-1. MOX fuel lead assembly site characterization: ANL-W FMF option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

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ID	Task Name	FTE-Work
53	Make premodification preparations	8.4 wks
54	Procure materials	6.5 wks
55	Construction/Installation	9.6 wks
56	Modify SAR	35.14 wks
57	Modify environmental permits	0 wks
58	**Analytical Facilities Modifications**	**139.85 wks**
59	Design modifications	12.6 wks
60	Make premodification preparations	17.55 wks
61	Specify equipment	25.2 wks
62	Procure materials/equipment	4.15 wks
63	Construction/Installation	55.35 wks
64	Modify SAR	25 wks
65	Modify environmental permits	0 wks
66	**Powder/Pellet/Rod Process Equipment**	**1,043.5 wk**
67	Design PPR process line	304.8 wks
68	Specify/Design PPR equipment	76.2 wks
69	Specify accountability system	11.6 wks
70	Procure process/accountability equipment	87.5 wks
71	Install PPR and accountability equipment	450 wks
72	Unit test process equipment	113.4 wks
73	**Bundle Assembly Process Equipment**	**72.15 wks**
74	Design assembly process line	18.9 wks
75	Specify/Design assembly equipment	9.45 wks
76	Procure process equipment	9.45 wks
77	Install process equipment	25.2 wks
78	Unit test process equipment	9.15 wks

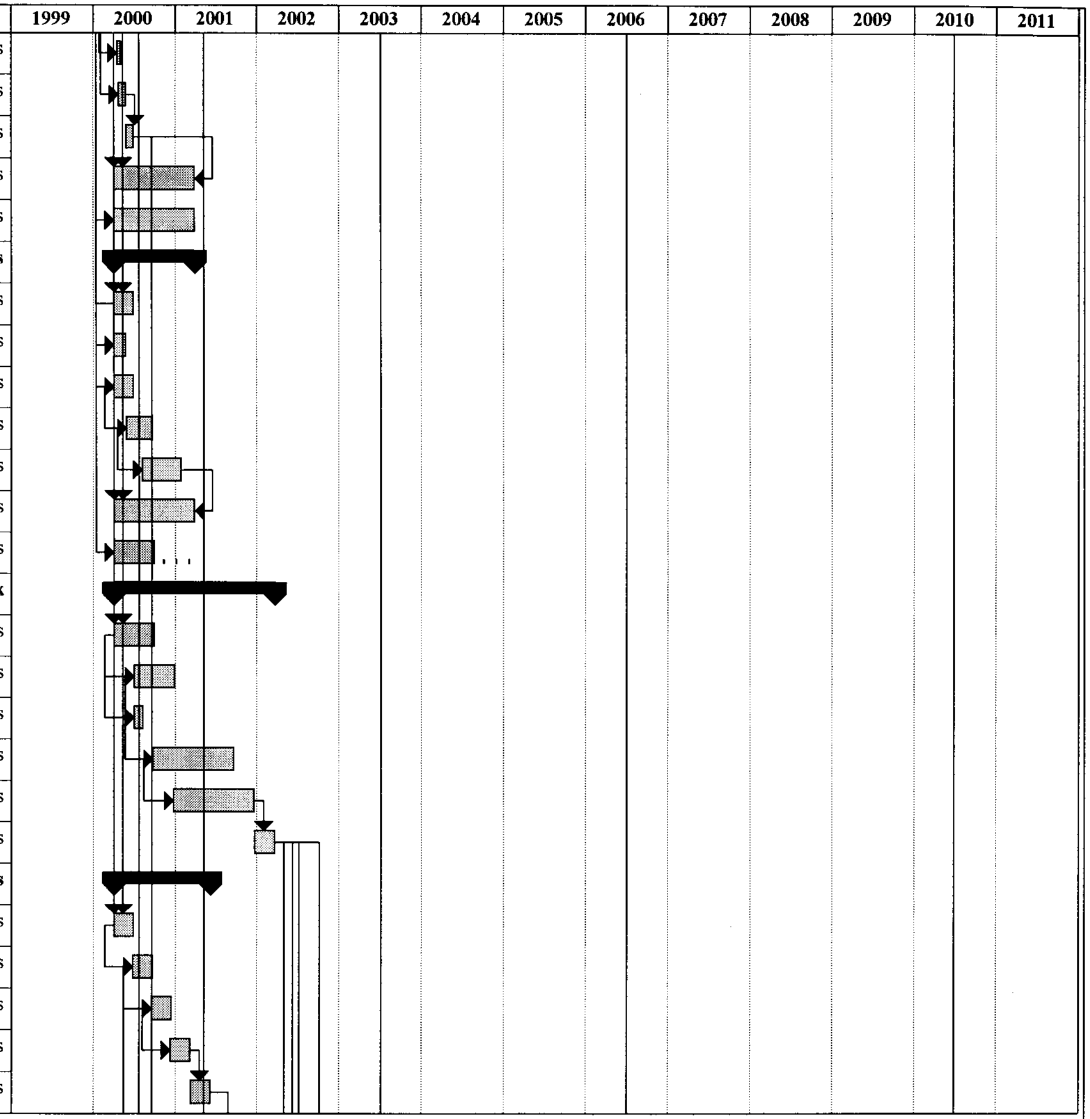

Fig. E-1. MOX fuel lead assembly site characterization: ANL-W FMF option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
79	**Fabrication Operations - Vault Storage**	**64.76 wks**
80	Develop operating procedures	3.6 wks
81	Conduct operational readiness review	13.64 wks
82	Receive Pu shipments and store Pu oxide	40.02 wks
83	Transfer Pu oxide to PPR processing	7.5 wks
84	Intrasite transportation (if needed)	0 wks
85	**Fabrication Operations - Powder/Pellets/Rods**	**7,169.64 wks**
86	Develop operating procedures	504 wks
87	Procure DU oxide	3.54 wks
88	Procure rod hardware	3.54 wks
89	Conduct preoperational readiness review	40.59 wks
90	Perform analytical qualification	64.05 wks
91	Conduct analytical operations	1,051.6 wk
92	Cold startup	471.2 wks
93	Conduct operational readiness review	40.92 wks
94	Hot startup operations	340.2 wks
95	Produce first qualified rod	0 wks
96	Rod fabrication operations	4,650 wks
97	Waste management operations	0 wks
98	Intrasite transportation (if needed)	0 wks
99	Program Target: First Qualified Rod Fabricated	0 wks
100	Program Target: Complete Rod Fabrication Operations	0 wks
101	**Fabrication Operations - Bundle Assembly**	**354 wks**
102	Develop operating procedures	39.65 wks
103	Procure bundle hardware	12.48 wks
104	Conduct operational readiness review	20.17 wks

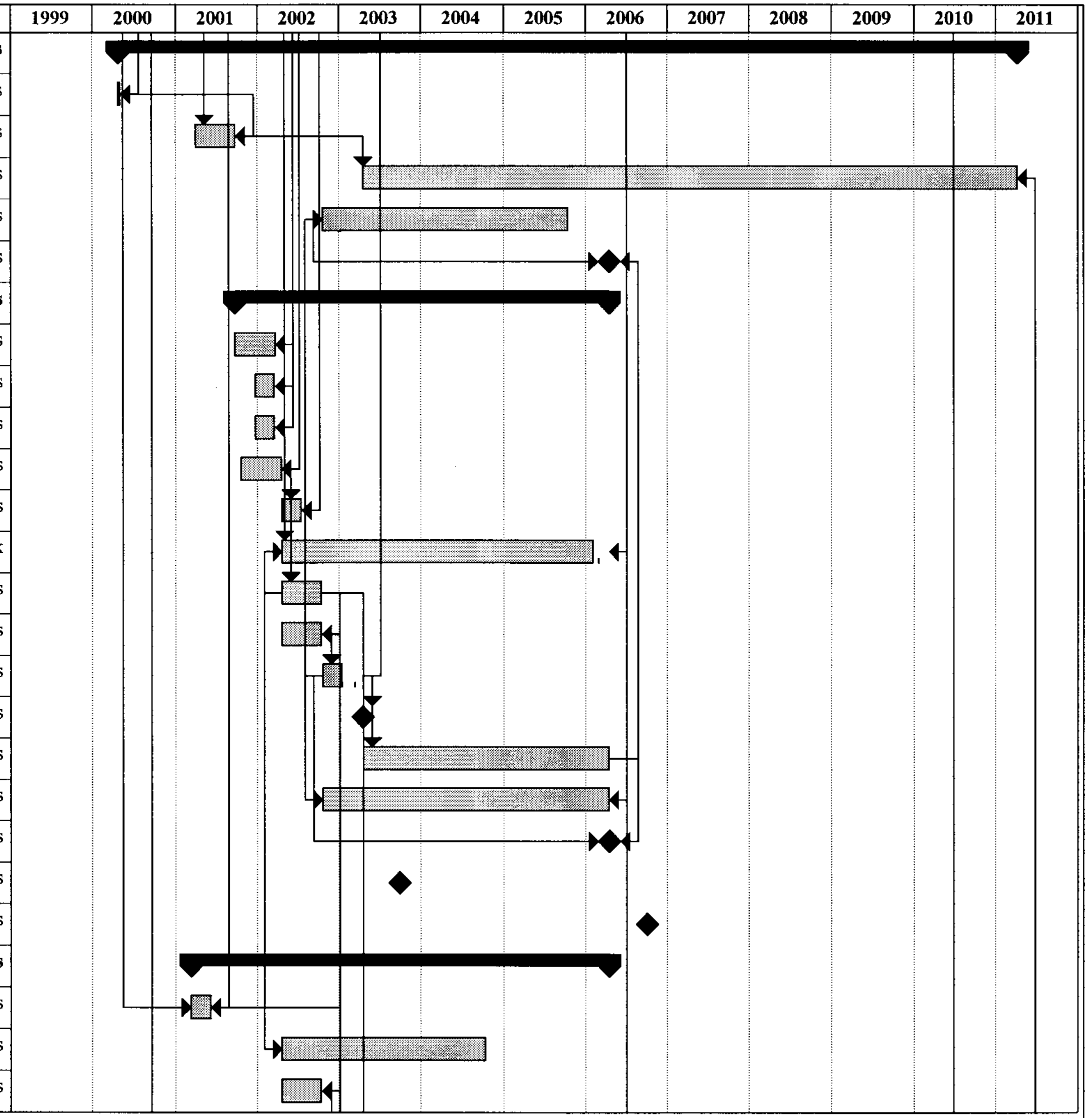

Fig. E-1. MOX fuel lead assembly site characterization: ANL-W FMF option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
105	Hot startup operations	56.7 wks
106	Bundle assembly operations	225 wks
107	Intrasite transportation (if needed)	0 wks
108	Program Target: Bundle Assembly Operations Complete	0 wks
109	**Fabrication Operations - Rod/Bundle Storage**	**101.29 wks**
110	Develop operating procedures	5.6 wks
111	Conduct operational readiness review	20.66 wks
112	Store rods and bundles	60.03 wks
113	Ship bundles	15 wks
114	**Facilities Standby**	**1,253.44 wk**
115	Develop standby plan	12.2 wks
116	Retain process qualifications	1,241.24 wk
117	Perform surveillance activities	0 wks
118	**Decontaminate & Decommission**	**479 wks**
119	Develop D&D plan	100 wks
120	Ship scrap Pu and DU for disposition	10 wks
121	D&D PPR processing facility	369 wks
122	Dispose of uncontaminated equipment	0 wks
123	Dispose of waste	0 wks

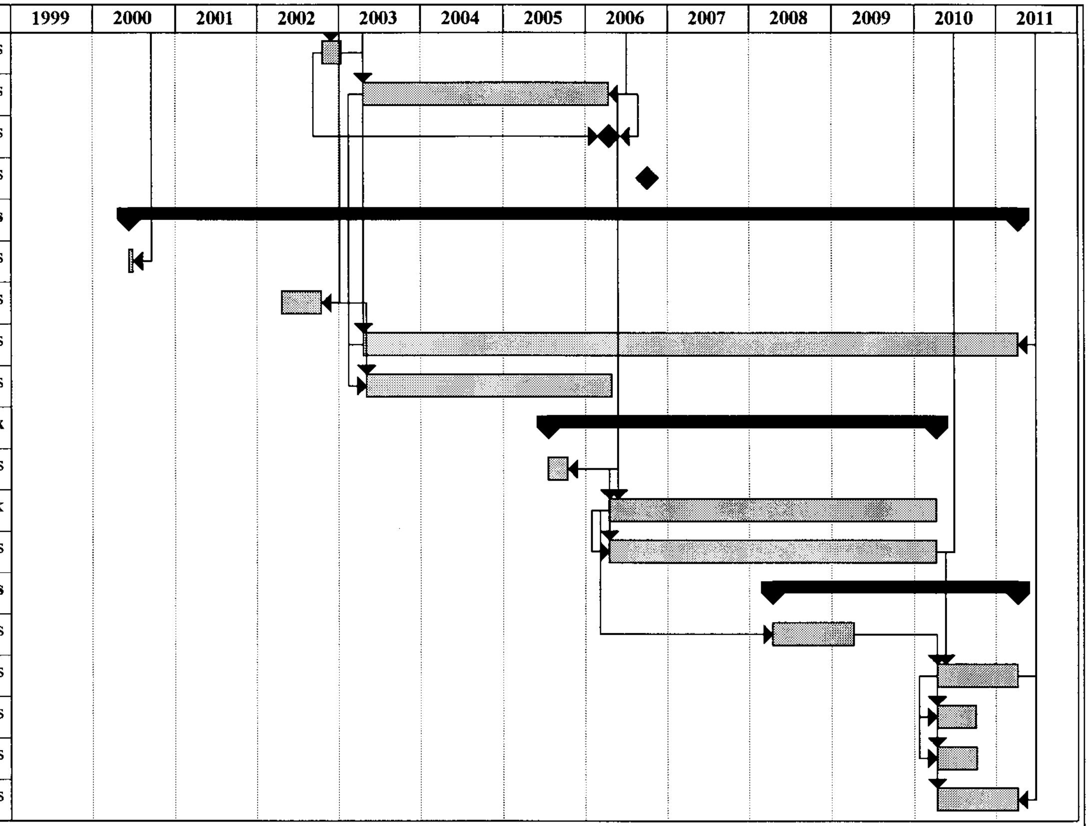

Fig. E-1. MOX fuel lead assembly site characterization: ANL-W FMF option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

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Appendix F
HANFORD FAA OPTION SCHEDULE

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Appendix F. HANFORD FAA OPTION SCHEDULE

This appendix contains summary-level schedule and effort data for the Hanford Fuel Assembly Area (FAA) option for fabricating MOX fuel for the proposed lead assembly project. Data for the Hanford FAA option were produced from the standardized project model developed by the Site Evaluation Team to collect, analyze, and display data for each of the candidate options. Cost data from the project model are displayed in Chaps. 2 and 5.

The schedule for each of the milestones, subprojects, and individual tasks is depicted graphically in a Gantt chart, which displays durations and constraints for the activities and events.

Effort is identified as “FTE-Work” and is tabulated for each task and summarized for each subproject. FTE-Work is interpreted as the average number of full-time-equivalent (FTE) persons of all classifications who work for the duration indicated by the schedule bar.

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ID	Task Name	FTE-Work
1	Program Decision: Select MOX fuel fabrication vendor	0 wks
2	Program Decision: Select MOX LA fabrication site	0 wks
3	**Project Management**	**6,606.3 wks**
4	Manage preoperational phase	1,305.3 wk
5	Manage operational phase	3,000 wks
6	Manage standby phase	1,100 wks
7	Develop plan for facilities upgrades	100 wks
8	Develop fabrication process plan	100 wks
9	Develop MOX LA fabrication plan	501 wks
10	Process support, operational phase	300 wks
11	Process support, standby phase	200 wks
12	**Infrastructure Upgrade/Modifications**	**294.81 wks**
13	Verify NEPA documentation	25.2 wks
14	Modify site agreements	0 wks
15	Modify site environmental permits	50.2 wks
16	Develop plan for S&S upgrades	37.8 wks
17	Upgrade physical security (if necessary)	74.8 wks
18	Upgrade MC&A (if necessary)	22 wks
19	Upgrade SST handling (if necessary)	1 wk
20	Upgrade other S&S features (if necessary)	3.5 wks
21	Complete site S&S plan	35.4 wks
22	Validate/Test S&S systems	26.4 wks
23	Modify emergency response plan	16.51 wks
24	Upgrade control center	0 wks
25	Upgrade fire department	0 wks
26	Upgrade medical department	0 wks

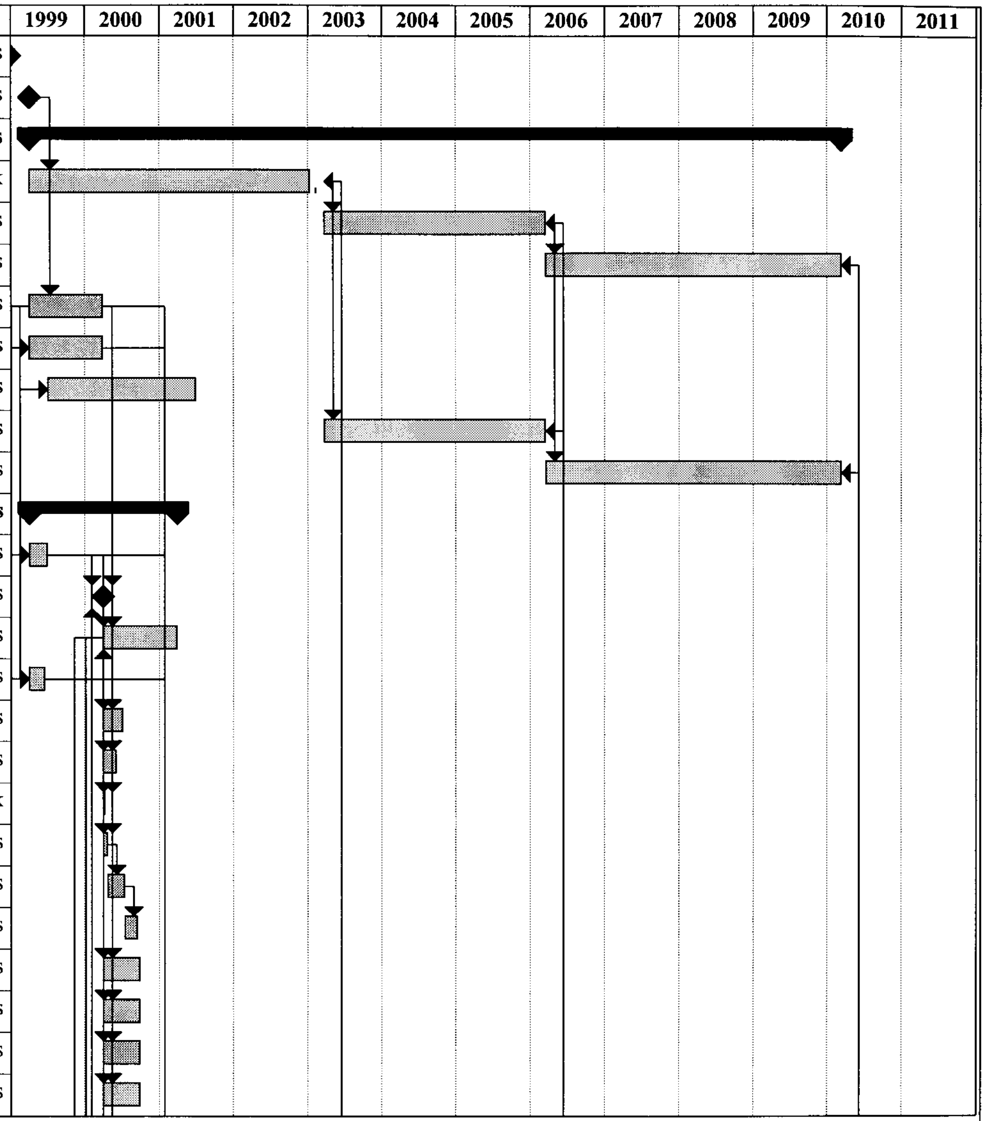

Fig. F-1. MOX fuel lead assembly site characterization: Hanford FAA option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
27	Upgrade/Modify waste management process	0 wks
28	Upgrade intrasite transportation	2 wks
29	**Vault(s) Modifications**	**0 wks**
30	Design modifications	0 wks
31	Make premodification preparations	0 wks
32	Procure materials	0 wks
33	Construction/Installation	0 wks
34	Modify SAR	0 wks
35	Modify environmental permits	0 wks
36	**Powder/Pellet/Rod Fabrication Facility Modifications**	**338.6 wks**
37	Design modifications	0 wks
38	Make premodification preparations	0 wks
39	Procure materials	12.4 wks
40	Construction/Installation	0 wks
41	Upgrade HP instrumentation	76.2 wks
42	Modify SAR	250 wks
43	Modify environmental permits	0 wks
44	**Bundle Assembly Facility Modifications**	**141.25 wks**
45	Design modifications	12.6 wks
46	Make premodification preparations	25.2 wks
47	Procure materials	0 wks
48	Construction/Installation	15.6 wks
49	Modify SAR	87.85 wks
50	Modify environmental permits	0 wks
51	**Bundle Storage Facility Modifications**	**89.25 wks**
52	Design modifications	2.8 wks

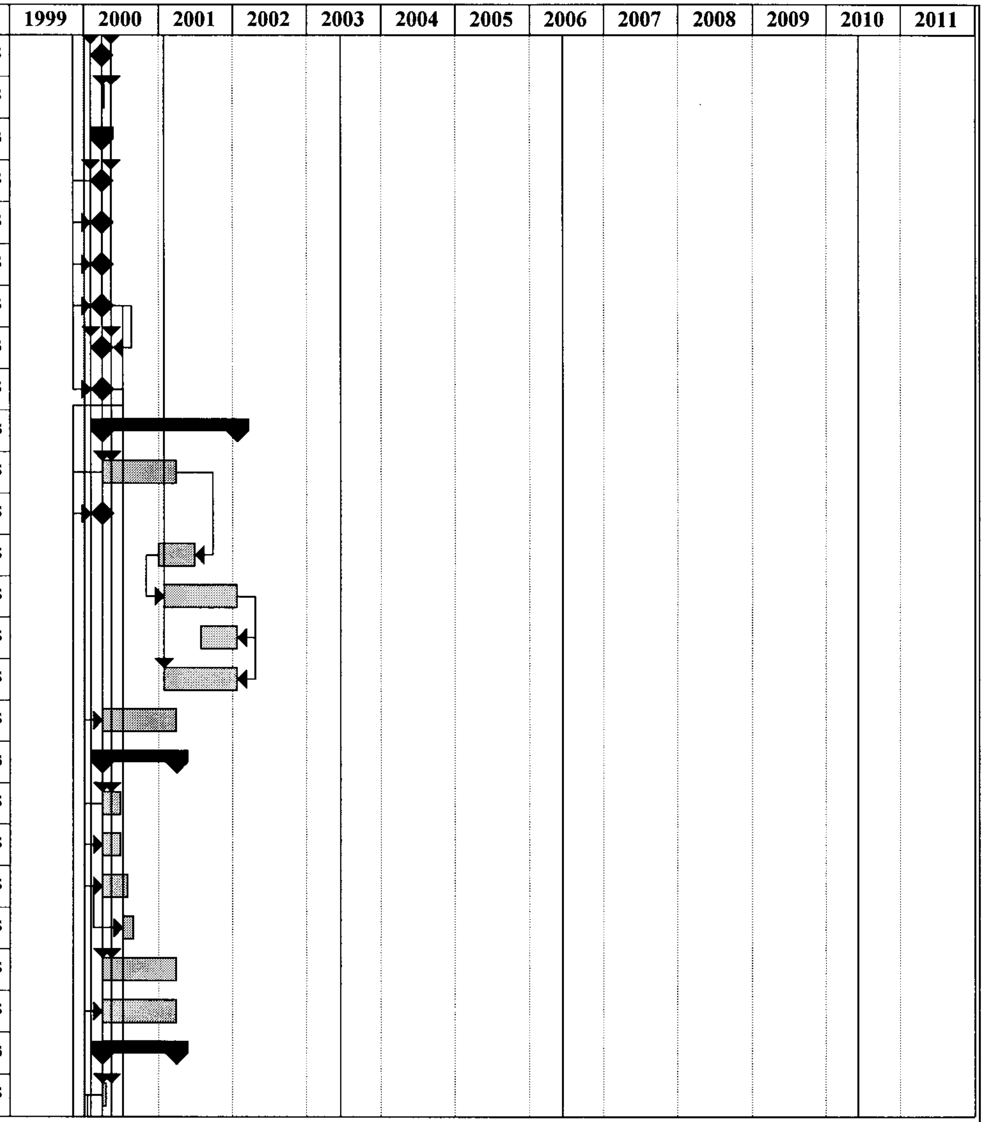

Fig. F-1. MOX fuel lead assembly site characterization: Hanford FAA option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
53	Make premodification preparations	1 wk
54	Procure materials	2.7 wks
55	Construction/Installation	14.5 wks
56	Modify SAR	68.25 wks
57	Modify environmental permits	0 wks
58	**Analytical Facilities Modifications**	**47.4 wks**
59	Design modifications	0 wks
60	Make premodification preparations	0 wks
61	Specify equipment	3.15 wks
62	Procure materials/equipment	6.35 wks
63	Construction/Installation	12.8 wks
64	Modify SAR	25.1 wks
65	Modify environmental permits	0 wks
66	**Powder/Pellet/Rod Process Equipment**	**1,025.2 wk**
67	Design PPR process line	239.4 wks
68	Specify/Design PPR equipment	51.2 wks
69	Specify accountability system	15.6 wks
70	Procure process/accountability equipment	75 wks
71	Install PPR and accountability equipment	500 wks
72	Unit test process equipment	144 wks
73	**Bundle Assembly Process Equipment**	**62.7 wks**
74	Design assembly process line	9.45 wks
75	Specify/Design assembly equipment	9.45 wks
76	Procure process equipment	9.45 wks
77	Install process equipment	25.2 wks
78	Unit test process equipment	9.15 wks

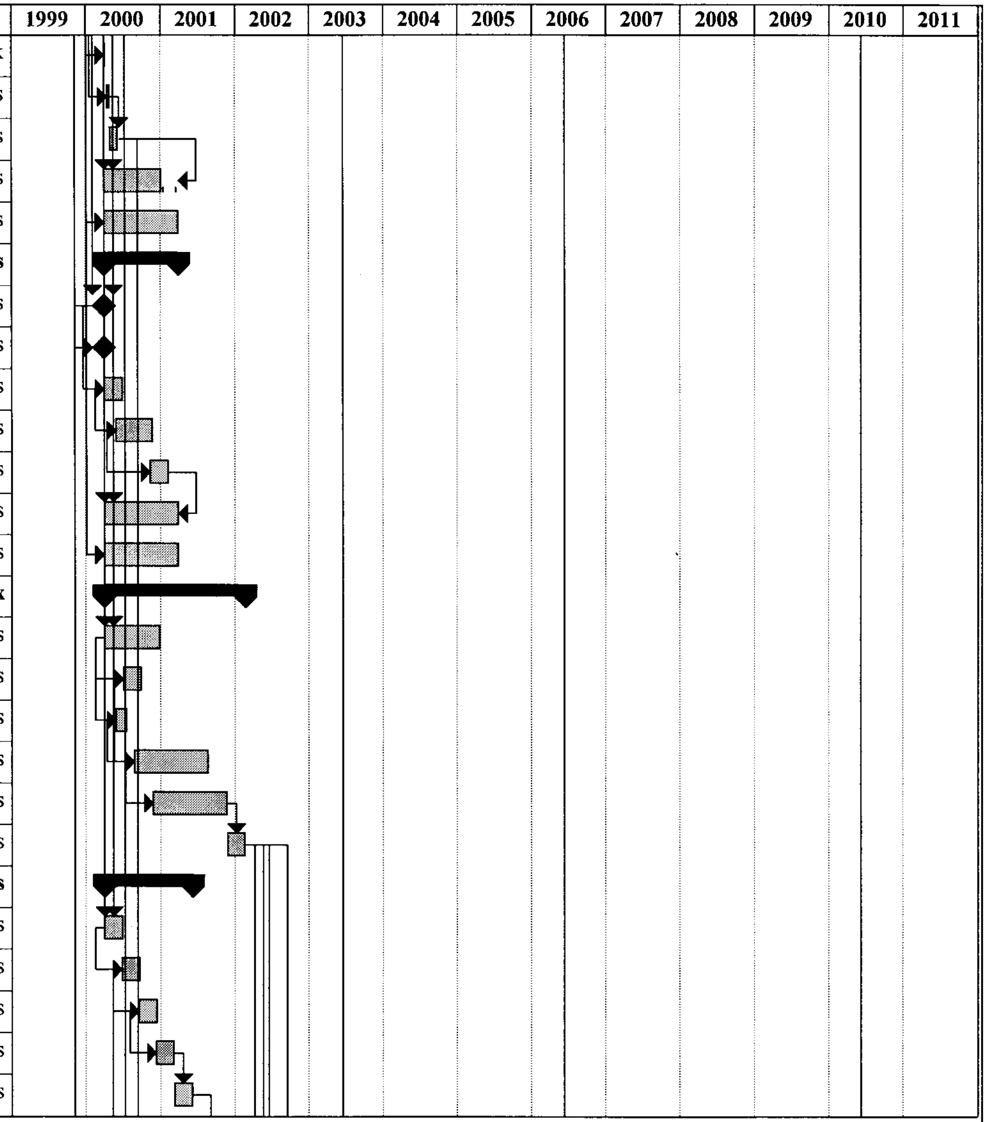

Fig. F-1. MOX fuel lead assembly site characterization: Hanford FAA option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
79	**Fabrication Operations - Vault Storage**	**78.5 wks**
80	Develop operating procedures	8.5 wks
81	Conduct operational readiness review	0 wks
82	Receive Pu shipments and store Pu oxide	40 wks
83	Transfer Pu oxide to PPR processing	30 wks
84	Intrasite transportation (if needed)	0 wks
85	**Fabrication Operations - Powder/Pellets/Rods**	**7,285.34 wks**
86	Develop operating procedures	565.8 wks
87	Procure DU oxide	3.72 wks
88	Procure rod hardware	3.72 wks
89	Conduct preoperational readiness review	166.05 wks
90	Perform analytical qualification	64.05 wks
91	Conduct analytical operations	1,018.6 wk
92	Cold startup	471.2 wks
93	Conduct operational readiness review	0 wks
94	Hot startup operations	342.2 wks
95	Produce first qualified rod	0 wks
96	Rod fabrication operations	4,650 wks
97	Waste management operations	0 wks
98	Intrasite transportation (if needed)	0 wks
99	Program Target: First Qualified Rod Fabricated	0 wks
100	Program Target: Complete Rod Fabrication Operations	0 wks
101	**Fabrication Operations - Bundle Assembly**	**363.44 wks**
102	Develop operating procedures	39.65 wks
103	Procure bundle hardware	12.48 wks
104	Conduct operational readiness review	33.21 wks

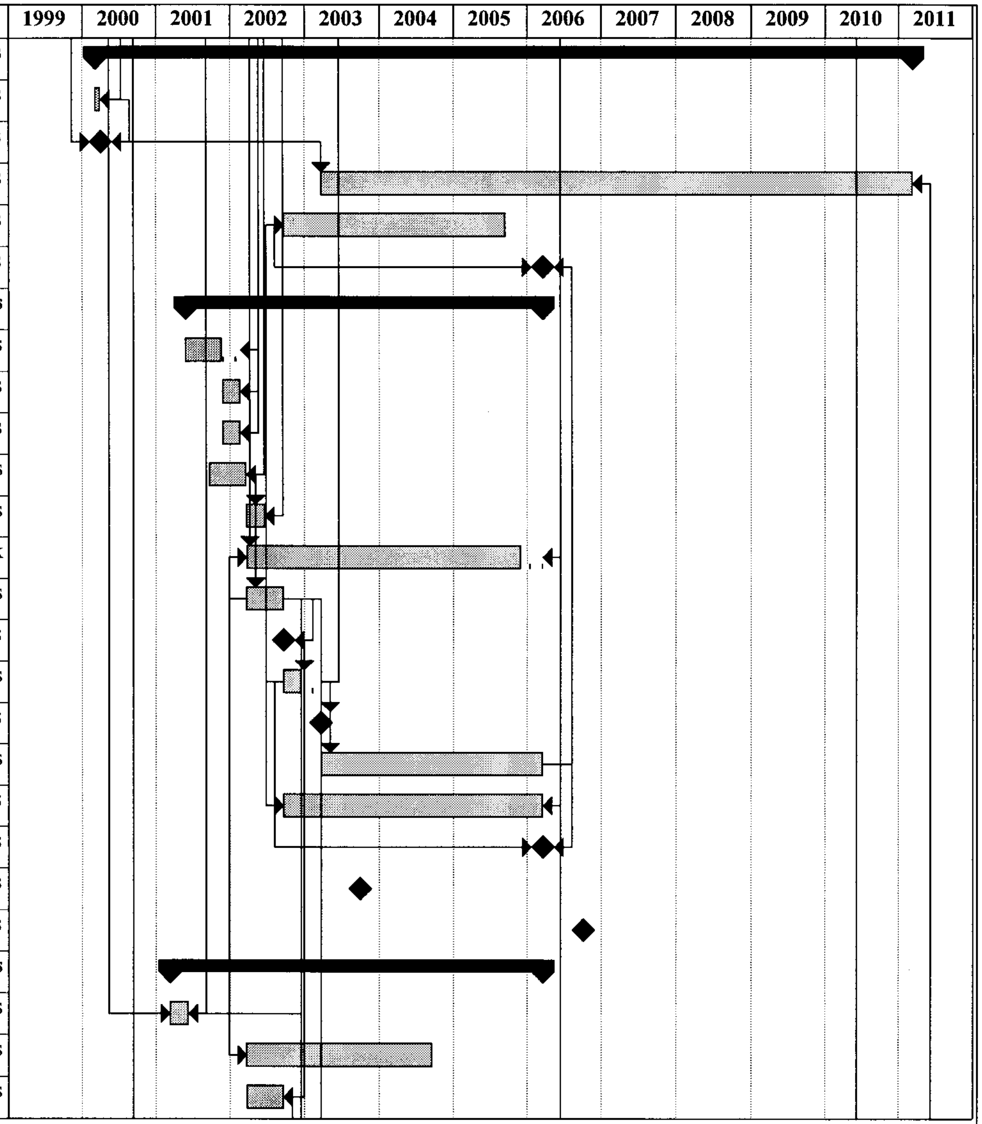

Fig. F-1. MOX fuel lead assembly site characterization: Hanford FAA option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
105	Hot startup operations	53.1 wks
106	Bundle assembly operations	225 wks
107	Intrasite transportation (if needed)	0 wks
108	Program Target: Bundle Assembly Operations Complete	0 wks
109	**Fabrication Operations - Rod/Bundle Storage**	**81.88 wks**
110	Develop operating procedures	4.2 wks
111	Conduct operational readiness review	22.68 wks
112	Store rods and bundles	40 wks
113	Ship bundles	15 wks
114	**Facilities Standby**	**1,252.6 wk**
115	Develop standby plan	12.6 wks
116	Retain process qualifications	1,240 wks
117	Perform surveillance activities	0 wks
118	**Decontaminate & Decommission**	**479 wks**
119	Develop D&D plan	100 wks
120	Ship scrap Pu and DU for disposition	10 wks
121	D&D PPR processing facility	369 wks
122	Dispose of uncontaminated equipment	0 wks
123	Dispose of waste	0 wks

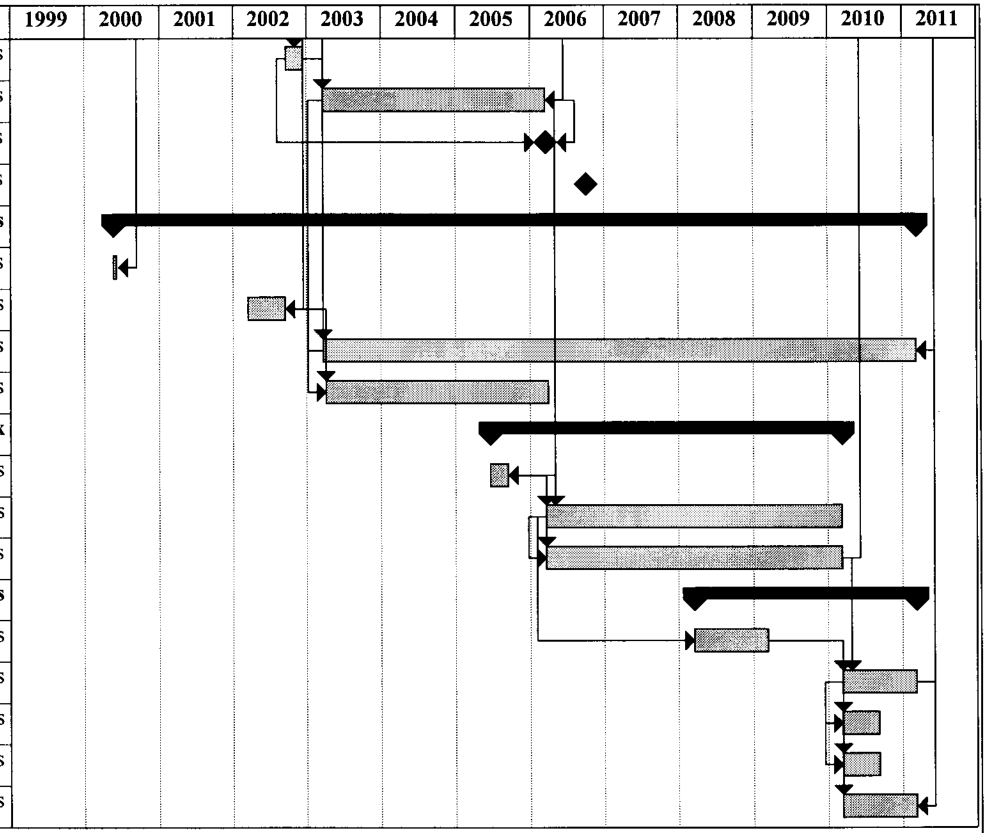

Fig. F-1. MOX fuel lead assembly site characterization: Hanford FAA option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

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Appendix G
LLNL PF-I3 OPTION SCHEDULE

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Appendix G. LLNL PF-I3 OPTION SCHEDULE

This appendix contains summary-level schedule and effort data for the Lawrence Livermore National Laboratory (LLNL) option for fabricating MOX fuel for the proposed lead assembly project. Data for the LLNL option were produced from the standardized project model developed by the Site Evaluation Team to collect, analyze, and display data for each of the candidate options. Cost data from the project model are displayed in Chaps. 2 and 6.

Schedule for each of the milestones, subprojects, and individual tasks is depicted graphically in a Gantt chart, which displays durations and constraints for the activities and events.

Effort is identified as "FTE-Work" and is tabulated for each task and summarized for each subproject. FTE-Work is interpreted as the average number of full-time-equivalent (FTE) persons of all classifications who work for the duration indicated by the schedule bar.

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ID	Task Name	FTE-Work
1	Program Decision: Select MOX fuel fabrication vendor	0 wks
2	Program Decision: Select MOX LA fabrication site	0 wks
3	**Project Management**	**5,520.08 wks**
4	Manage preoperational phase	1,217.88 wk
5	Manage operational phase	2,100 wks
6	Manage standby phase	1,001 wks
7	Develop plan for facilities upgrades	100 wks
8	Develop fabrication process plan	100 wks
9	Develop MOX LA fabrication plan	501 wks
10	Process support, operational phase	300 wks
11	Process support, standby phase	200.2 wks
12	**Infrastructure Upgrade/Modifications**	**155.31 wks**
13	Verify NEPA documentation	12.6 wks
14	Modify site agreements	0 wks
15	Modify site environmental permits	15.21 wks
16	Develop plan for S&S upgrades	20.4 wks
17	Upgrade physical security (if necessary)	31.2 wks
18	Upgrade MC&A (if necessary)	39.6 wks
19	Upgrade SST handling (if necessary)	0 wks
20	Upgrade other S&S features (if necessary)	3 wks
21	Complete site S&S plan	17.4 wks
22	Validate/Test S&S systems	12 wks
23	Modify emergency response plan	1.9 wks
24	Upgrade control center	0 wks
25	Upgrade fire department	0 wks
26	Upgrade medical department	0 wks

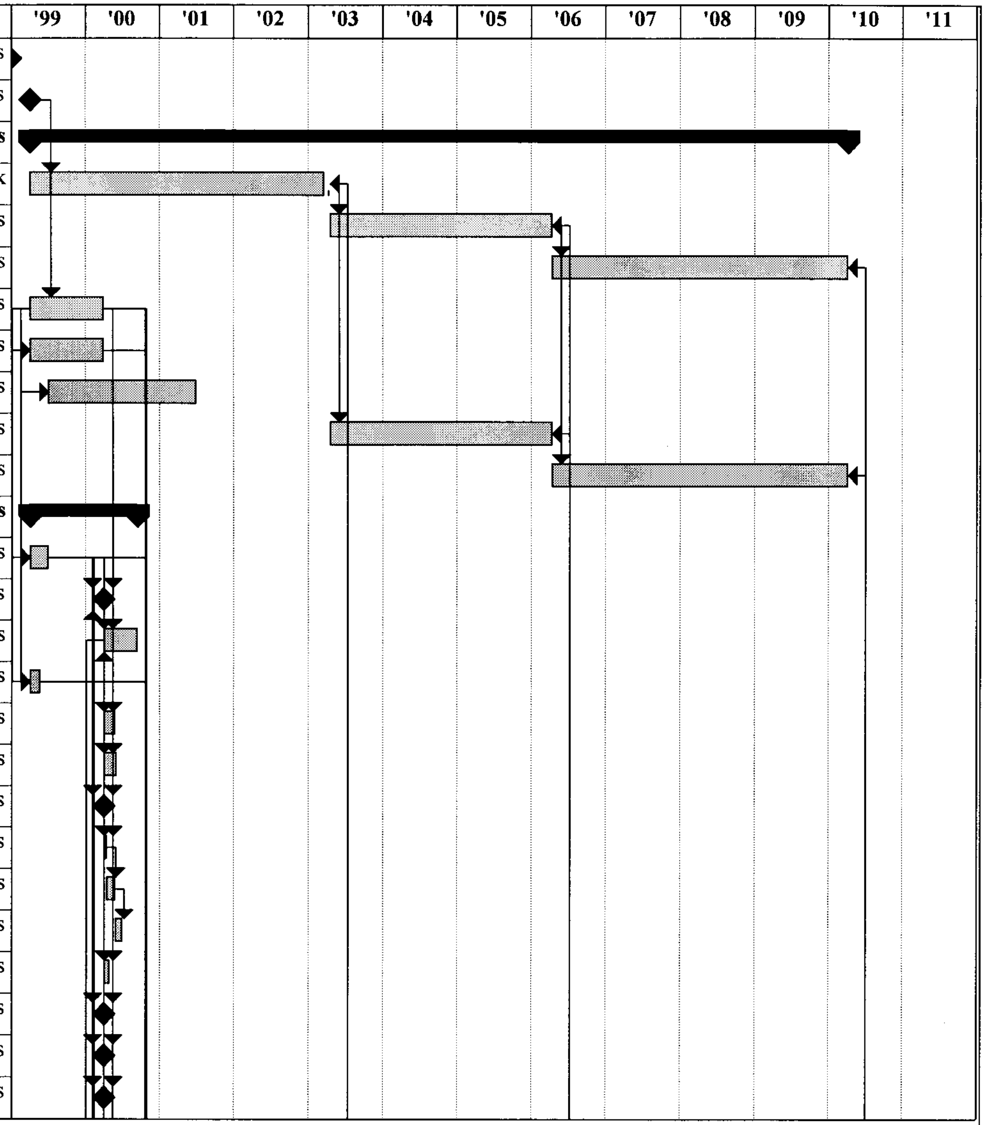

Fig. G-1. MOX fuel lead assembly site characterization: LLNL PF-I3 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
27	Upgrade/Modify waste management process	0 wks
28	Upgrade intrasite transportation	2 wks
29	**Vault(s) Modifications**	**8.25 wks**
30	Design modifications	3 wks
31	Make premodification preparations	2 wks
32	Procure materials	1.25 wks
33	Construction/Installation	2 wks
34	Modify SAR	0 wks
35	Modify environmental permits	0 wks
36	**Powder/Pellet/Rod Fabrication Facility Modifications**	**265.06 wks**
37	Design modifications	50.8 wks
38	Make premodification preparations	51.2 wks
39	Procure materials	31.2 wks
40	Construction/Installation	92.4 wks
41	Upgrade HP instrumentation	25.6 wks
42	Modify SAR	13.86 wks
43	Modify environmental permits	0 wks
44	**Bundle Assembly Facility Modifications**	**72.98 wks**
45	Design modifications	12.6 wks
46	Make premodification preparations	25.2 wks
47	Procure materials	2.9 wks
48	Construction/Installation	25.2 wks
49	Modify SAR	7.08 wks
50	Modify environmental permits	0 wks
51	**Bundle Storage Facility Modifications**	**33.84 wks**
52	Design modifications	3.8 wks

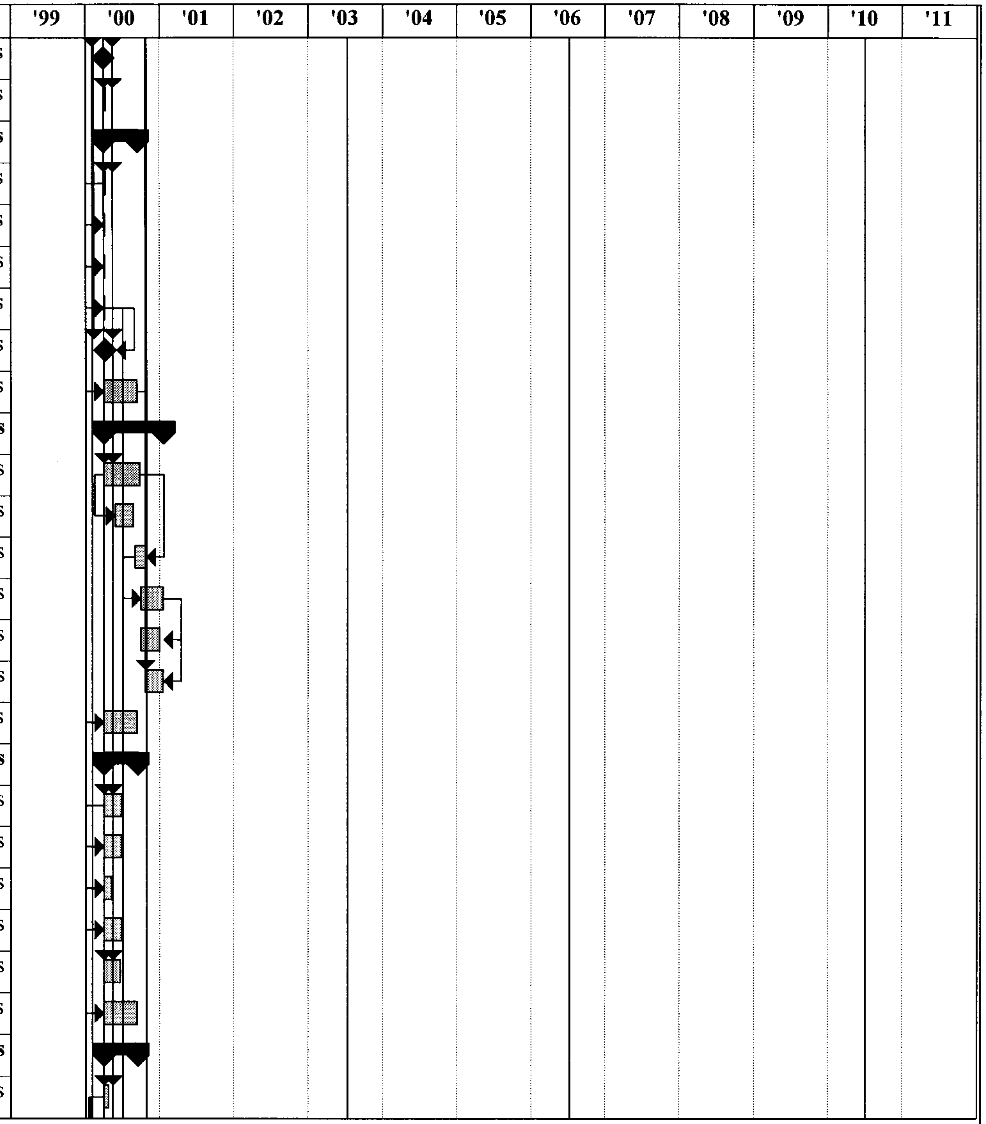

Fig. G-1. MOX fuel lead assembly site characterization: LLNL PF-I3 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
53	Make premodification preparations	7 wks
54	Procure materials	3 wks
55	Construction/Installation	12.5 wks
56	Modify SAR	7.54 wks
57	Modify environmental permits	0 wks
58	**Analytical Facilities Modifications**	**118.34 wks**
59	Design modifications	0 wks
60	Make premodification preparations	0 wks
61	Specify equipment	11.7 wks
62	Procure materials/equipment	6.35 wks
63	Construction/Installation	98.4 wks
64	Modify SAR	1.89 wks
65	Modify environmental permits	0 wks
66	**Powder/Pellet/Rod Process Equipment**	**1,323.7 wk**
67	Design PPR process line	254 wks
68	Specify/Design PPR equipment	76.2 wks
69	Specify accountability system	17.4 wks
70	Procure process/accountability equipment	87.5 wks
71	Install PPR and accountability equipment	750 wks
72	Unit test process equipment	138.6 wks
73	**Bundle Assembly Process Equipment**	**72.15 wks**
74	Design assembly process line	18.9 wks
75	Specify/Design assembly equipment	9.45 wks
76	Procure process equipment	9.45 wks
77	Install process equipment	25.2 wks
78	Unit test process equipment	9.15 wks

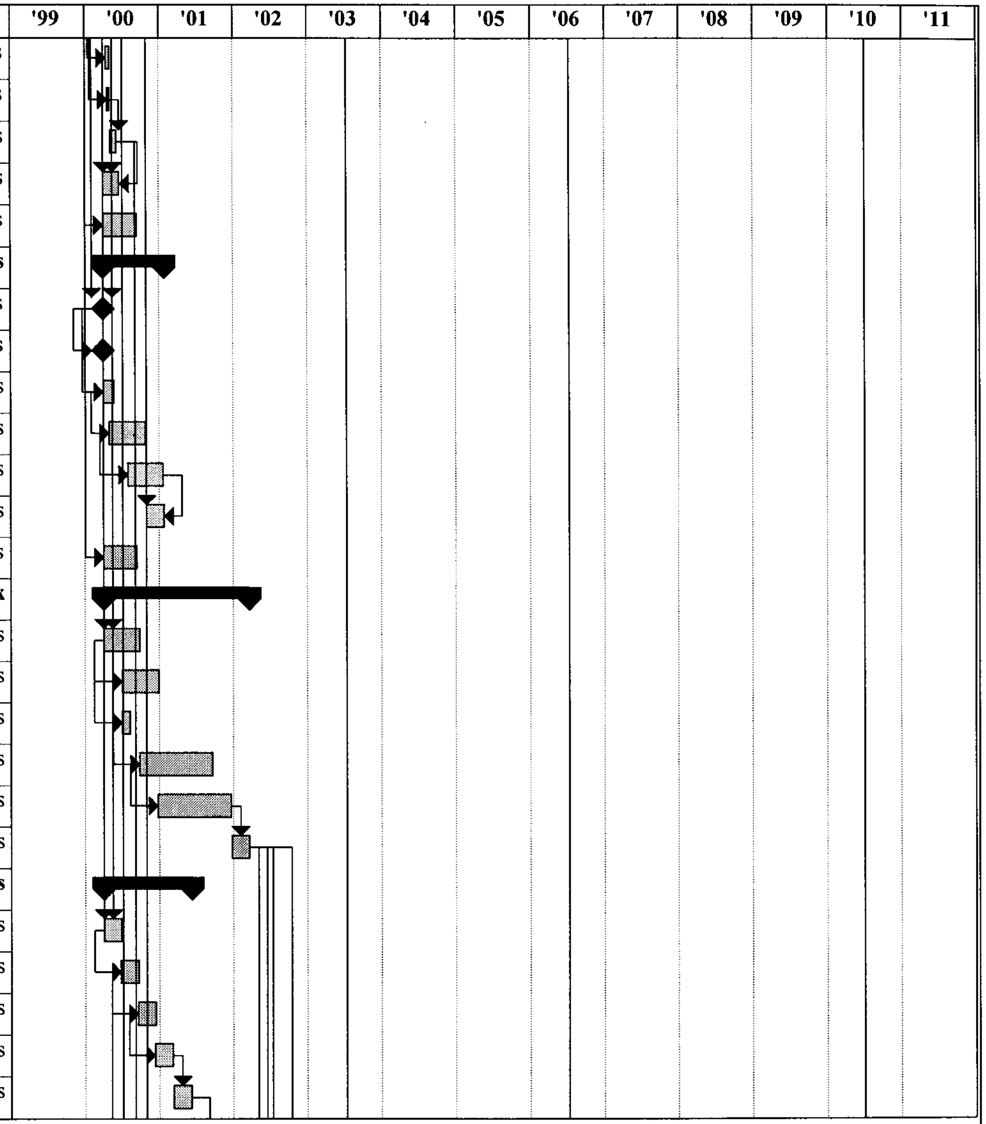

Fig. G-1. MOX fuel lead assembly site characterization: LLNL PF-I3 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
79	**Fabrication Operations - Vault Storage**	**51.06 wks**
80	Develop operating procedures	3.6 wks
81	Conduct operational readiness review	7.44 wks
82	Receive Pu shipments and store Pu oxide	40.02 wks
83	Transfer Pu oxide to PPR processing	0 wks
84	Intrasite transportation (if needed)	0 wks
85	**Fabrication Operations - Powder/Pellets/Rods**	**6,473.98 wks**
86	Develop operating procedures	579.6 wks
87	Procure DU oxide	3.54 wks
88	Procure rod hardware	3.54 wks
89	Conduct preoperational readiness review	25.83 wks
90	Perform analytical qualification	64.05 wks
91	Conduct analytical operations	1,101.1 wk
92	Cold startup	446.4 wks
93	Conduct operational readiness review	22.32 wks
94	Hot startup operations	327.6 wks
95	Produce first qualified rod	0 wks
96	Rod fabrication operations	3,900 wks
97	Waste management operations	0 wks
98	Intrasite transportation (if needed)	0 wks
99	Program Target: First Qualified Rod Fabricated	0 wks
100	Program Target: Complete Rod Fabrication Operations	0 wks
101	**Fabrication Operations - Bundle Assembly**	**344.9 wks**
102	Develop operating procedures	39.65 wks
103	Procure bundle hardware	12.48 wks
104	Conduct operational readiness review	11.07 wks

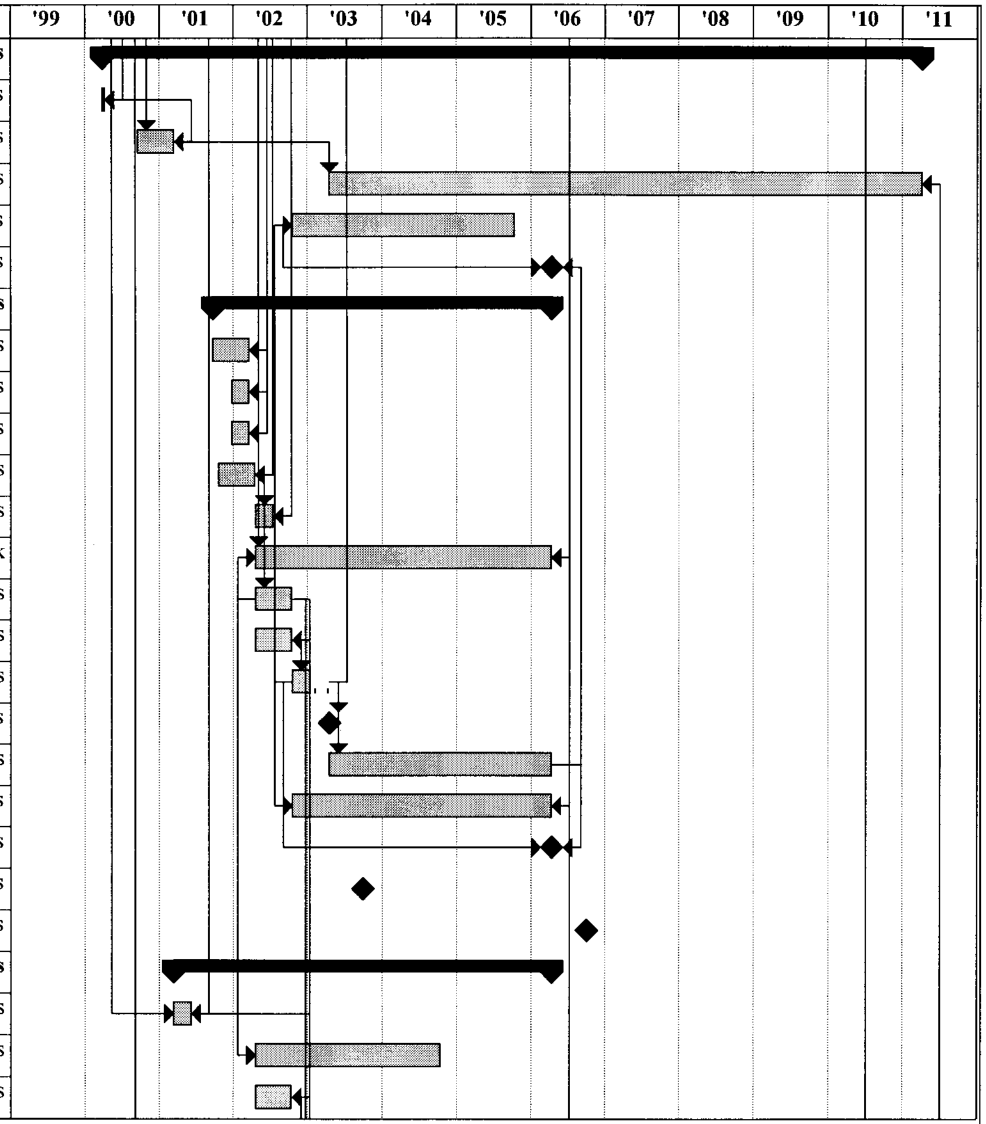

Fig. G-1. MOX fuel lead assembly site characterization: LLNL PF-I3 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
105	Hot startup operations	56.7 wks
106	Bundle assembly operations	225 wks
107	Intrasite transportation (if needed)	0 wks
108	Program Target: Bundle Assembly Operations Complete	0 wks
109	**Fabrication Operations - Rod/Bundle Storage**	**77.54 wks**
110	Develop operating procedures	9.6 wks
111	Conduct operational readiness review	11.34 wks
112	Store rods and bundles	41.6 wks
113	Ship bundles	15 wks
114	**Facilities Standby**	**1,253.44 wk**
115	Develop standby plan	12.2 wks
116	Retain process qualifications	1,241.24 wk
117	Perform surveillance activities	0 wks
118	**Decontaminate & Decommission**	**479 wks**
119	Develop D&D plan	100 wks
120	Ship scrap Pu and DU for disposition	10 wks
121	D&D PPR processing facility	369 wks
122	Dispose of uncontaminated equipment	0 wks
123	Dispose of waste	0 wks

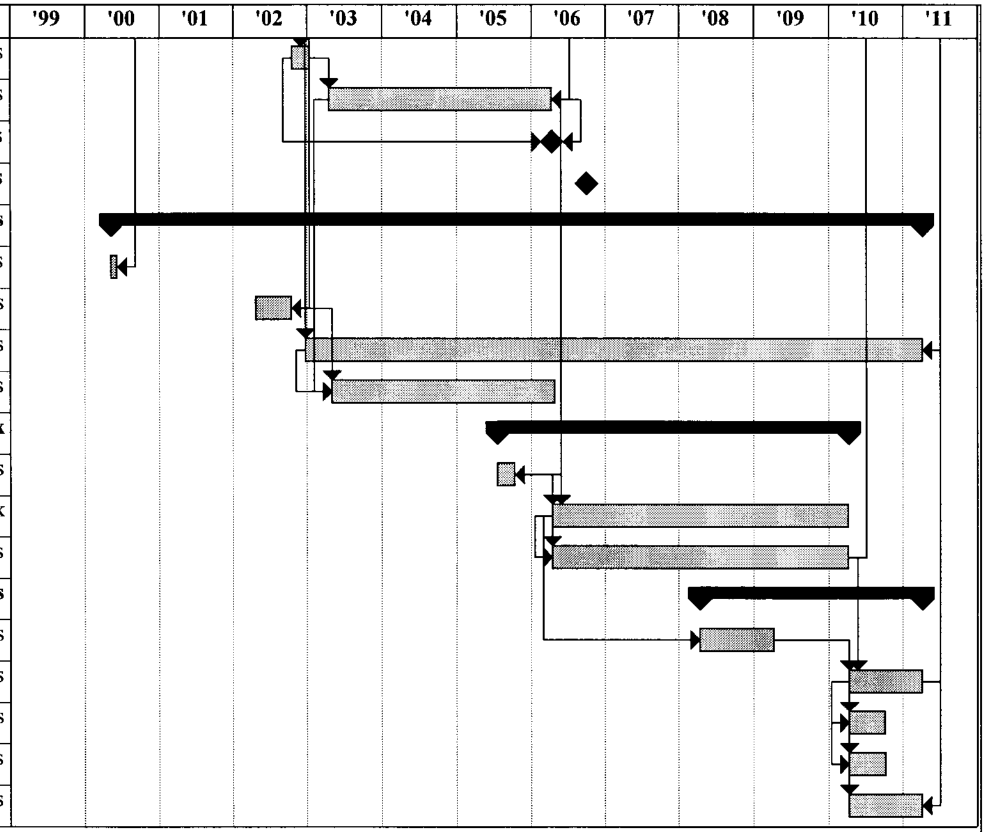

Fig. G-1. MOX fuel lead assembly site characterization: LLNL PF-I3 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

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Appendix H
LANL PF-4 OPTION SCHEDULE

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Appendix H. LANL PF-4 OPTION SCHEDULE

This appendix contains summary-level schedule and effort data for the Los Alamos National Laboratory (LANL) option for fabricating MOX fuel for the proposed lead assembly project. Data for the LANL option were produced from the standardized project model developed by the Site Evaluation Team to collect, analyze, and display data for each of the candidate options. Cost data from the project model are displayed in Chaps. 2 and 7.

The schedule for each of the milestones, subprojects, and individual tasks is depicted graphically in a Gantt chart, which displays durations and constraints for the activities and events.

Effort is identified as "FTE-Work" and is tabulated for each task and summarized for each subproject. FTE-Work is interpreted as the average number of full-time-equivalent (FTE) persons of all classifications who work for the duration indicated by the schedule bar.

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ID	Task Name	FTE-Work
1	Program Decision: Select MOX fuel fabrication vendor	0 wks
2	Program Decision: Select MOX LA fabrication site	0 wks
3	**Project Management**	**3,324.6 wks**
4	Manage preoperational phase	973 wks
5	Manage operational phase	750 wks
6	Manage standby phase	400.4 wks
7	Develop plan for facilities upgrades	100 wks
8	Develop fabrication process plan	100 wks
9	Develop MOX LA fabrication plan	501 wks
10	Process support, operational phase	300 wks
11	Process support, standby phase	200.2 wks
12	**Infrastructure Upgrade/Modifications**	**52.08 wks**
13	Verify NEPA documentation	7.8 wks
14	Modify site agreements	0 wks
15	Modify site environmental permits	12.48 wks
16	Develop plan for S&S upgrades	11.6 wks
17	Upgrade physical security (if necessary)	5 wks
18	Upgrade MC&A (if necessary)	5.7 wks
19	Upgrade SST handling (if necessary)	0 wks
20	Upgrade other S&S features (if necessary)	0 wks
21	Complete site S&S plan	2 wks
22	Validate/Test S&S systems	4.5 wks
23	Modify emergency response plan	2 wks
24	Upgrade control center	0 wks
25	Upgrade fire department	0 wks
26	Upgrade medical department	0 wks

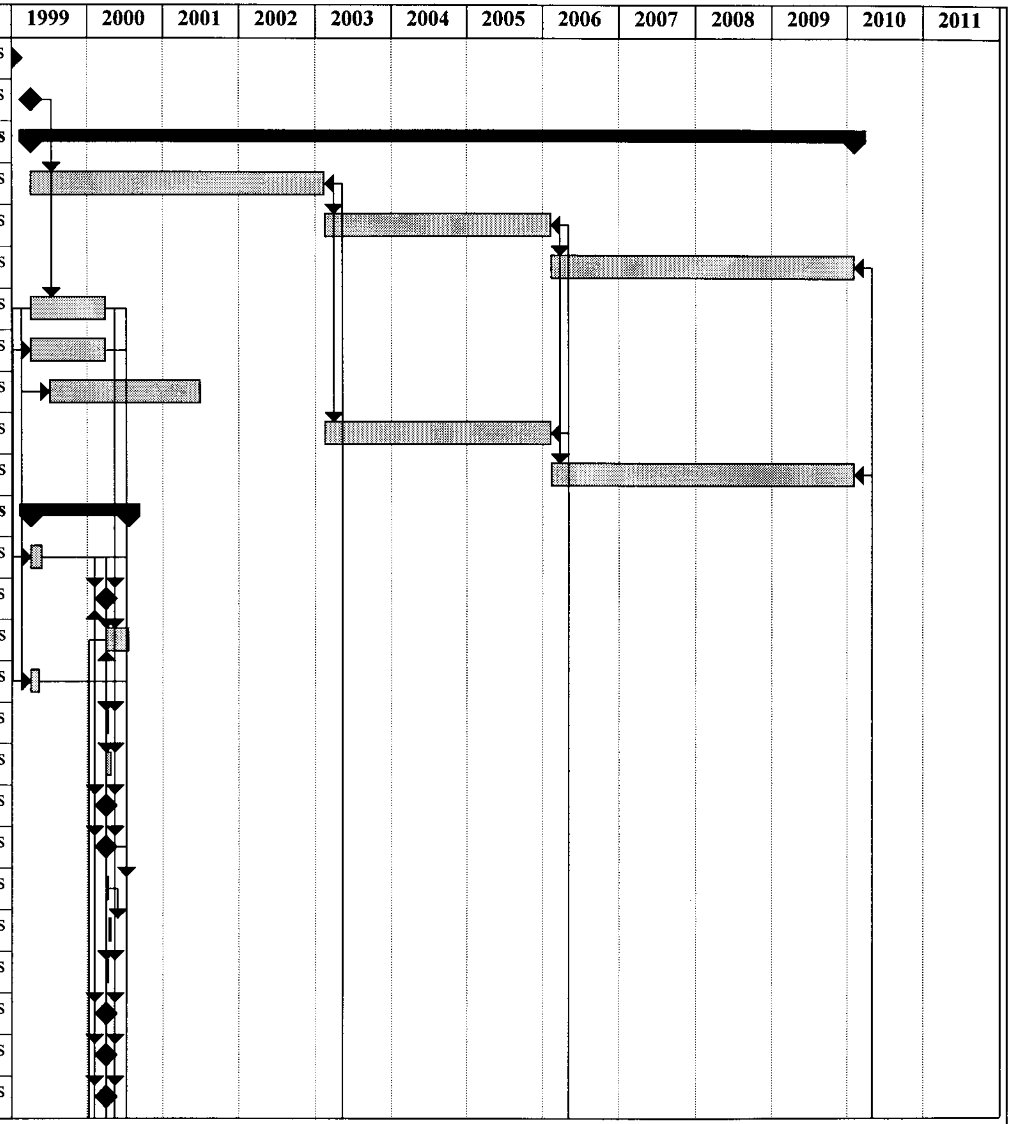

Fig. H-1. MOX fuel lead assembly site characterization: LANL PF-4 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
27	Upgrade/Modify waste management process	0 wks
28	Upgrade intrasite transportation	1 wk
29	**Vault(s) Modifications**	**0 wks**
30	Design modifications	0 wks
31	Make premodification preparations	0 wks
32	Procure materials	0 wks
33	Construction/Installation	0 wks
34	Modify SAR	0 wks
35	Modify environmental permits	0 wks
36	**Powder/Pellet/Rod Fabrication Facility Modifications**	**53.32 wks**
37	Design modifications	11.6 wks
38	Make premodification preparations	16 wks
39	Procure materials	0 wks
40	Construction/Installation	19 wks
41	Upgrade HP instrumentation	6.72 wks
42	Modify SAR	0 wks
43	Modify environmental permits	0 wks
44	**Bundle Assembly Facility Modifications**	**37.8 wks**
45	Design modifications	12.6 wks
46	Make premodification preparations	25.2 wks
47	Procure materials	0 wks
48	Construction/Installation	0 wks
49	Modify SAR	0 wks
50	Modify environmental permits	0 wks
51	**Bundle Storage Facility Modifications**	**13.35 wks**
52	Design modifications	3.8 wks

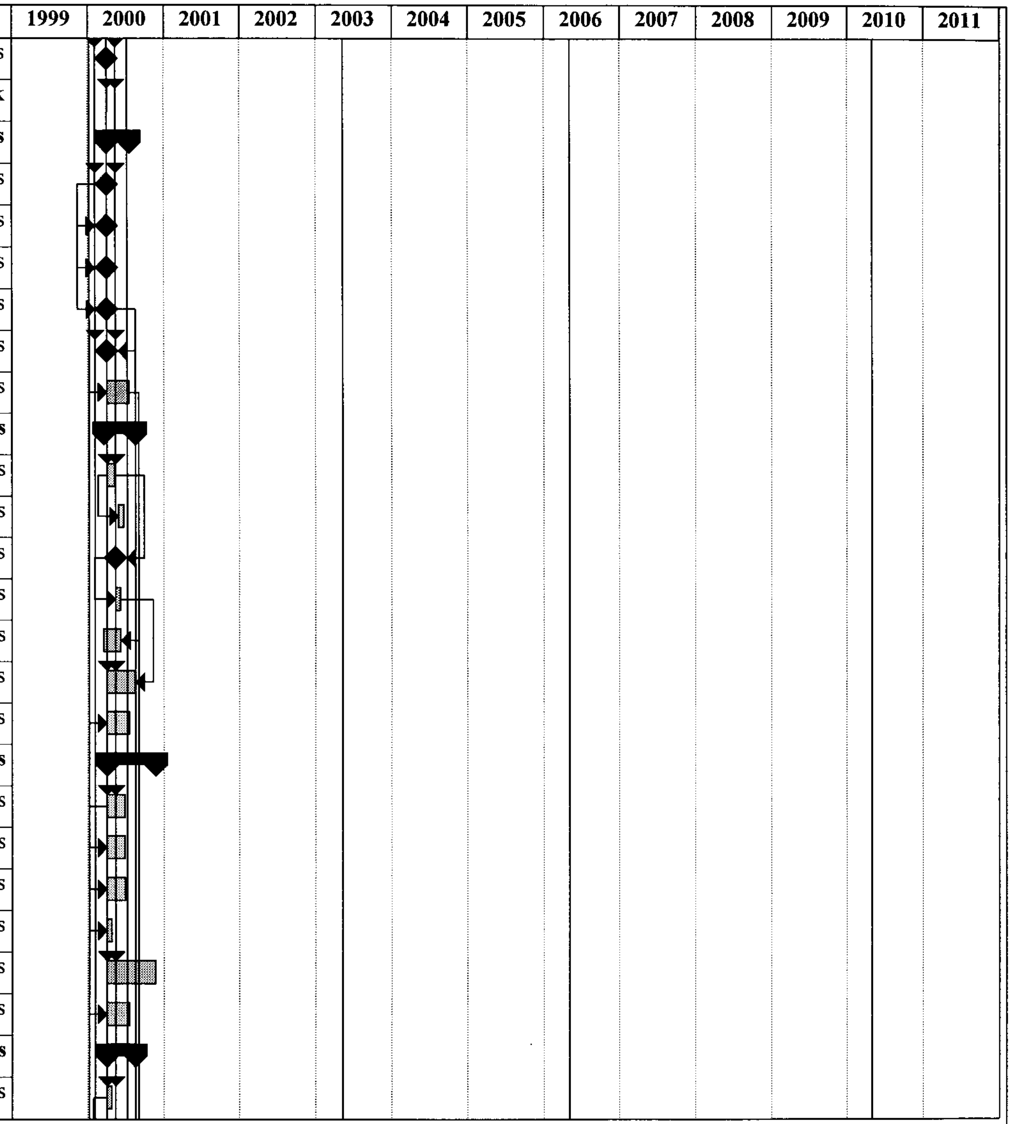

Fig. H-1. MOX fuel lead assembly site characterization: LANL PF-4 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
53	Make premodification preparations	0.8 wks
54	Procure materials	2 wks
55	Construction/Installation	6.75 wks
56	Modify SAR	0 wks
57	Modify environmental permits	0 wks
58	**Analytical Facilities Modifications**	**11.78 wks**
59	Design modifications	0 wks
60	Make premodification preparations	0 wks
61	Specify equipment	3.9 wks
62	Procure materials/equipment	3.2 wks
63	Construction/Installation	4.68 wks
64	Modify SAR	0 wks
65	Modify environmental permits	0 wks
66	**Powder/Pellet/Rod Process Equipment**	**465.2 wks**
67	Design PPR process line	100.8 wks
68	Specify/Design PPR equipment	25.6 wks
69	Specify accountability system	4.5 wks
70	Procure process/accountability equipment	87.5 wks
71	Install PPR and accountability equipment	147.6 wks
72	Unit test process equipment	99.2 wks
73	**Bundle Assembly Process Equipment**	**72.15 wks**
74	Design assembly process line	18.9 wks
75	Specify/Design assembly equipment	9.45 wks
76	Procure process equipment	9.45 wks
77	Install process equipment	25.2 wks
78	Unit test process equipment	9.15 wks

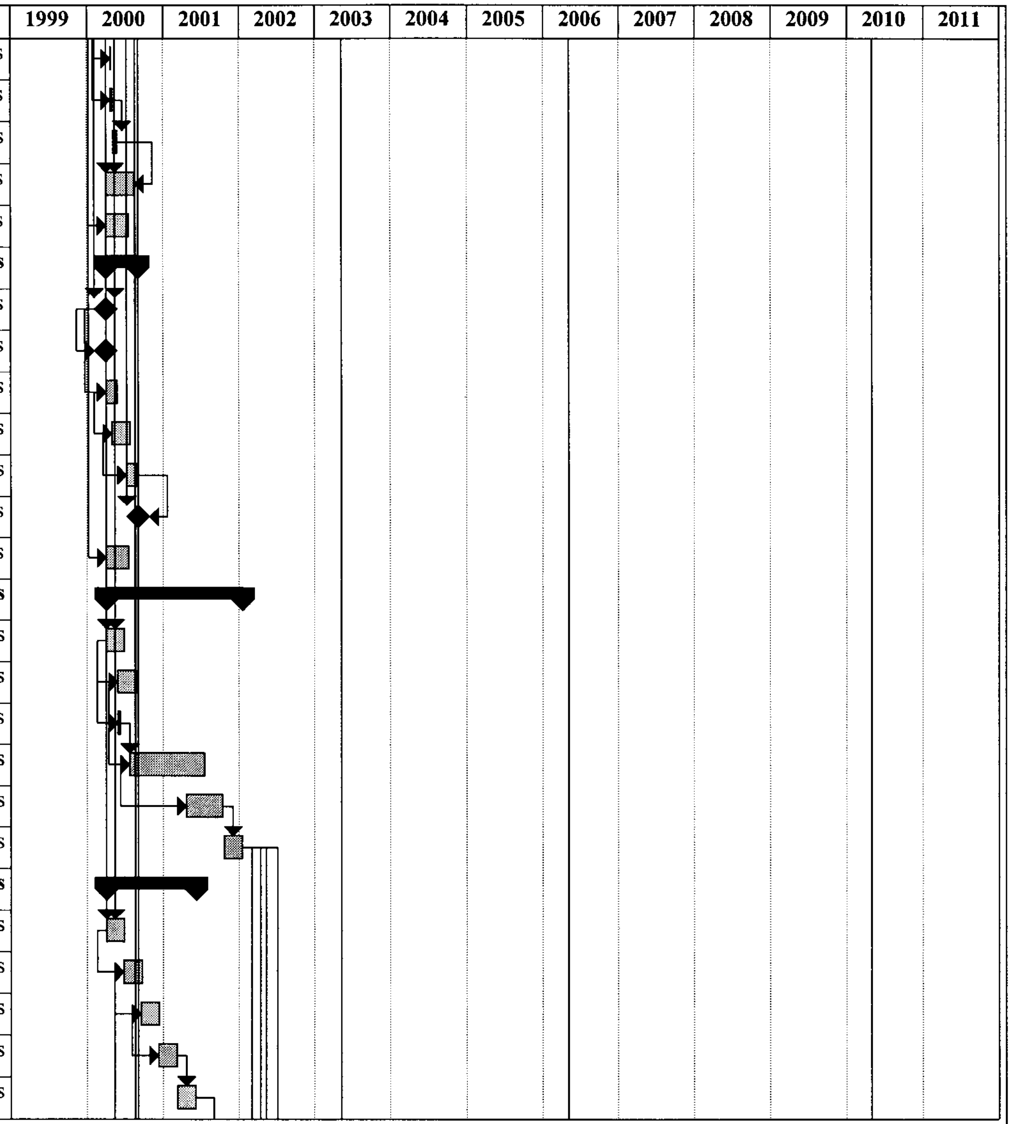

Fig. H-1. MOX fuel lead assembly site characterization: LANL PF-4 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
79	**Fabrication Operations - Vault Storage**	**0 wks**
80	Develop operating procedures	0 wks
81	Conduct operational readiness review	0 wks
82	Receive Pu shipments and store Pu oxide	0 wks
83	Transfer Pu oxide to PPR processing	0 wks
84	Intrasite transportation (if needed)	0 wks
85	**Fabrication Operations - Powder/Pellets/Rods**	**4,432.16 wks**
86	Develop operating procedures	183 wks
87	Procure DU oxide	3.54 wks
88	Procure rod hardware	3.54 wks
89	Conduct preoperational readiness review	0 wks
90	Perform analytical qualification	0 wks
91	Conduct analytical operations	0 wks
92	Cold startup	369 wks
93	Conduct operational readiness review	0 wks
94	Hot startup operations	264.6 wks
95	Produce first qualified rod	0 wks
96	Rod fabrication operations	3,600 wks
97	Waste management operations	0 wks
98	Intrasite transportation (if needed)	8.48 wks
99	Program Target: First Qualified Rod Fabricated	0 wks
100	Program Target: Complete Rod Fabrication Operations	0 wks
101	**Fabrication Operations - Bundle Assembly**	**348.81 wks**
102	Develop operating procedures	39.65 wks
103	Procure bundle hardware	12.46 wks
104	Conduct operational readiness review	0 wks

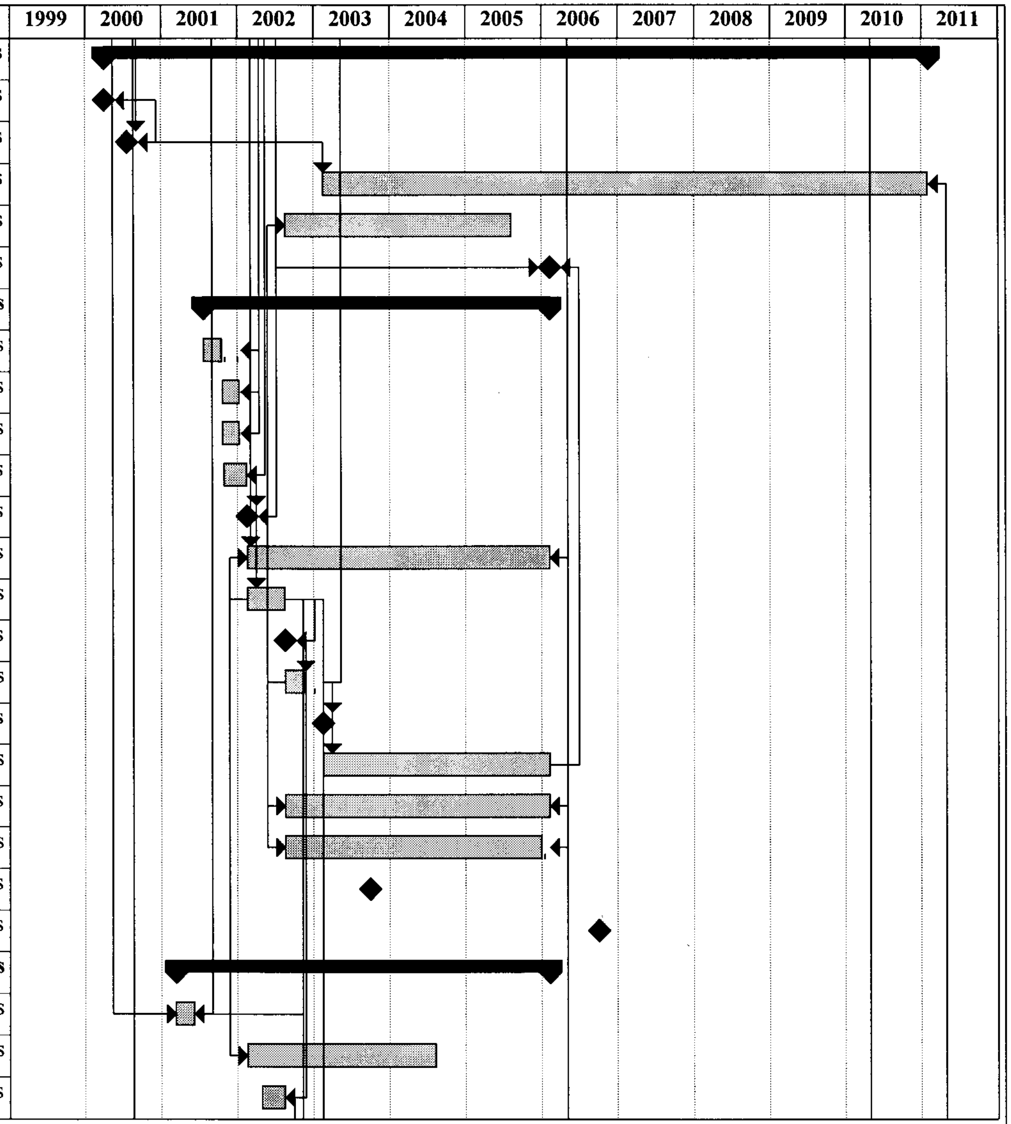

Fig. H-1. MOX fuel lead assembly site characterization: LANL PF-4 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

ID	Task Name	FTE-Work
105	Hot startup operations	56.7 wks
106	Bundle assembly operations	225 wks
107	Intrasite transportation (if needed)	15 wks
108	Program Target: Bundle Assembly Operations Complete	0 wks
109	**Fabrication Operations - Rod/Bundle Storage**	**94.03 wks**
110	Develop operating procedures	4 wks
111	Conduct operational readiness review	0 wks
112	Store rods and bundles	60.03 wks
113	Ship bundles	30 wks
114	**Facilities Standby**	**853.04 wks**
115	Develop standby plan	12.2 wks
116	Retain process qualifications	840.84 wks
117	Perform surveillance activities	0 wks
118	**Decontaminate & Decommission**	**479 wks**
119	Develop D&D plan	100 wks
120	Ship scrap Pu and DU for disposition	10 wks
121	D&D PPR processing facility	369 wks
122	Dispose of uncontaminated equipment	0 wks
123	Dispose of waste	0 wks

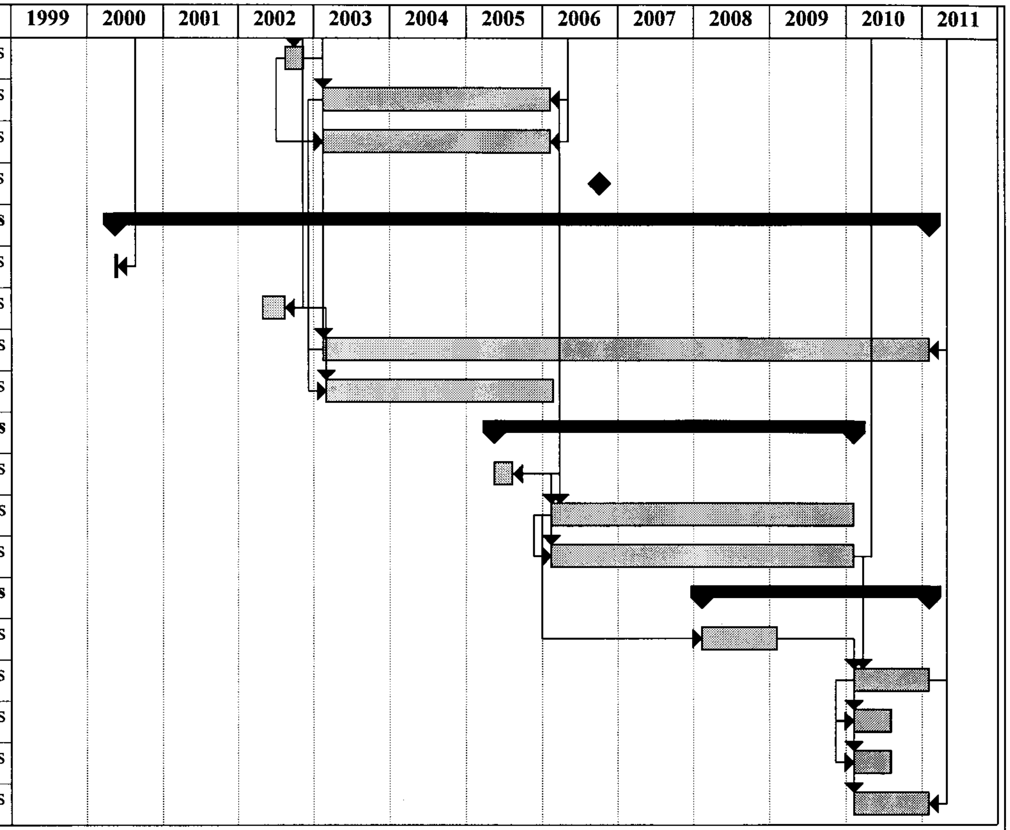

Fig. H-1. MOX fuel lead assembly site characterization: LANL PF-4 option schedule.

FTE = full time equivalent
Timescale is in fiscal years beginning October 1998

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