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Stanley Zygmunt, NMT-6, Los Alamos National Laboratory

Damian Peko, Department of Energy Office of Fissile Materials Disposition

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STATUS OF THE PIT DISASSEMBLY AND CONVERSION FACILITY

Stanley Zygmunt
Los Alamos National Laboratory

Damian Peko
Department of Energy
Office of Fissile Materials Disposition

Abstract

A planned new facility, the Pit Disassembly and Conversion Facility (PDCF) will be used to disassemble the nation's inventory of surplus nuclear weapons pits and convert the plutonium recovered from those pits into a form suitable for storage, international inspection, and final disposition. Sized to handle 35 metric tons of plutonium from pits and other sources over its 10-year operating life, the PDCF will apply the Advanced Recovery and Integrated Extraction System (ARIES) technology. ARIES process technology has been developed at Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL) and an integrated system is being demonstrated LANL. Four sites were considered for locating the PDCF: Pantex Plant, Savannah River Site (SRS), Idaho National Engineering and Environmental Laboratory (INEEL), and Hanford Site. Each site offers a different opportunity for constructing the PDCF, ranging from a new building at Pantex Plant to using an existing building at Hanford Site or INEEL. The Surplus Plutonium Disposition Environmental Impact Statement was prepared by the Department of Energy (DOE) Office of Fissile Materials Disposition (OFMD) to aid in site selection. This paper describes the initial scoping activities, preconceptual and conceptual design work, and the status of the PDCF.

Introduction

In the aftermath of the Cold War, significant quantities of weapons-usable fissile materials (primarily plutonium and highly enriched uranium) have become surplus to national defense needs both in the United States and Russia. Continued implementation of arms reduction agreements is expected to result in further weapons dismantlement and increases in stockpiles of surplus weapons-usable fissile materials. Weapons dismantlement yields a weapons pit that contains special nuclear material. The 1970 Treaty on Non-Proliferation of Nuclear Weapons and presidential directives (1)(2) drives disassembly of these pits, as well as the disposition of the recovered plutonium under international safeguards and inspection.

The DOE OFMD published the "Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement" (PEIS) in December 1996 (3). The Record of Decision (ROD) for the PEIS, dated January 14, 1997(4), stated that DOE would pursue a hybrid approach for the disposition of weapons-usable plutonium that allows immobilization in either glass or ceramic form and allows burning some of the surplus plutonium as mixed oxide (MOX) fuel in existing reactors. Surplus pits must be disassembled and the recovered plutonium converted to an oxide to support either disposition option, and thus pit disassembly and conversion is an integral part of the DOE disposition program. DOE decided that the extent to which either or both disposition options would be used would ultimately depend in part upon a National Environmental Policy Act (NEPA) review. Subsequently, the "Surplus Plutonium Disposition Environmental Impact Statement" (SPD EIS), currently in progress, was tiered from the PEIS. In addition to determining the extent to which one or both of the disposition options would be used, the SPD EIS would evaluate siting of the disposition options and pit disassembly and conversion at the candidate sites identified in the PEIS. For pit disassembly and conversion, the candidate sites are Pantex Plant, SRS, INEEL, and Hanford Site

Because the pit disassembly and conversion of the plutonium are essential to both disposition options, DOE has initiated a project to develop PDCF to handle the inventory of surplus pits. The PDCF is based on ARIES for pit disassembly, conversion of the metal to oxide, and packaging of the oxide. Individual processes that make up ARIES have been developed by LLNL and LANL. ARIES is being demonstrated as an integrated system at LANL. The ARIES process is a dry (non-aqueous) process that cuts the pits in half and separates the plutonium from other pit components by using hydrogen to convert the plutonium metal to a loose hydride powder. The hydride powder is converted to a nitride powder then to an oxide powder, which is packaged in storage containers that meet DOE standards for storage and, with the proper transportation overpack, meet the requirements for safe and secure transport. Containers of oxide are non-destructively assayed and stored, pending movement to the disposition facilities.

A hardened structure, the PDCF will be capable of receiving pits and plutonium metal and producing an oxide product suitable for disposition and international safeguards and inspection. The PDCF includes support functions needed to handle all the parts and waste generated from pit disassembly.

The schedule for construction of the PDCF is aggressive, with construction starting in the year 2000 and the facility in normal operations by 2005. This paper describes the work completed to date to scope the facility; identifies the effort to prepare the preconceptual and conceptual designs, as well as cost information to support the PDCF; and describes the current status of PDCF.

Description of the Work

A project team approach was used in the initial scoping and preconceptual design of the PDCF. Team members were recruited for the expertise they could contribute to defining the needs of the PDCF and the resulting team included members with expertise in the following areas:

- waste management,
- process chemical engineering,
- systems engineering,
- drafting,
- radiation protection,
- environmental permitting,
- facility construction,
- treaties,
- safeguards and security,
- nuclear facilities modeling,
- authorization basis/hazard analysis, and
- risk assessment.

The team conducted a needs analysis for the PDCF and documented the analysis in the form of informational fact sheets that identify requirements that impact the facility. Each fact sheet identifies a limiting rule, regulation, or condition; describes how the topic impacts the facility; identifies issues; identifies options for meeting requirements or resolving issues; and identifies impacts to the facility cost, schedule, or design.

Technical fact sheets were prepared documenting the ARIES demonstration process. The technical fact sheets document the performance of each module, defining the function, processing time, waste generation, and space and utility requirements for each module. The technical fact sheets attempt to predict changes in the modules needed to scale from demonstration activities to the full-sized PDCF.

A classified source-term fact sheet, "Advanced Recovery and Integrated Extraction System Source Term Fact Sheet" (5), was prepared. This fact sheet defines the pits and other plutonium metal that feed the PDCF.

A process logic flow diagram, "Process Logic Flow Diagram for Pit Disassembly and Conversion for Fissile Matter Disposition" (6), was prepared based on the fact sheets. The process logic flow diagram defines the activities requiring space or equipment needed to process the incoming pits and plutonium metal into canned plutonium oxide ready for transfer to the next disposition facility. The process logic flow diagram also defines the activities needed to handle the nonplutonium parts from the pits and the waste generated by the process.

An optimization analysis, "Exposure Minimization/ Layout Optimization" (7), was performed. The analysis used computer modeling to determine the number of process modules needed, the number of operators needed to operate the modules, and an estimate of the radiation exposure the module operators would receive. Operator exposures were controlled by optimizing the spacing of the equipment and by adding shielding to the glove boxes. The objective at this stage of the project was to demonstrate that exposure levels could be controlled within regulatory requirements and within project objectives with reasonable control schemes. The optimization analysis yielded a conceptual layout and floor plan for the ARIES process.

The operator staffing for the process predicted by the optimization analysis was used as the basis for estimating the total staffing. The support and management staff was estimated by identifying individual functions needed and estimating the required staffing for each function based on the operating staff size and experience at similar nuclear facilities. Exposures for the operator staff were generated as part of the optimization analysis. The exposures for the remaining staff were estimated based on experience at the LANL Plutonium Facility.

A technical risk assessment (TRA), "Technical Risk Assessment for the Department of Energy Pit Disassembly and Conversion Facility" (8), was conducted.
The assessment identified and rated technical and programmatic issues that posed a risk to meeting the schedule and performance requirements of the PDCF.
The TRA is being used to direct and prioritize research and development efforts and to advise OFMD on ways to resolve programmatic issues.

The process layout generated from the optimization analysis and the staffing estimate was given to an architect/engineering (AE) firm experienced in the design of nuclear facilities. The AE estimated space needs for support functions, utilities, and material handling for pit receiving, storage vaults, and waste handling. The AE generated conceptual design drawings and cost estimates that were combined with functional requirements developed by the team to comprise the "Design-Only Conceptual Design Report for the Pit Disassembly and Conversion Facility" (DOCDR) (9). The DOCDR has successfully passed validation and supports a line-item funding request for $47M for preliminary and detailed design work.

Candidate Sites

The PEIS ROD identified four candidate sites for locating the PDCF: Pantex Plant, SRS, INEEL, and Hanford Site. Each site offers a different opportunity for construction of the PDCF and collocation of the disposition facilities for MOX fuel fabrication and for immobilization. Suitability of using existing buildings was determined by reviewing excess buildings at each site and comparing the size and condition of excess space against the projects needs. The approach for each site, as well as the options for collocating the disposition options, are summarized as follows.

- Pantex Plant—Construct the PDCF as a new building. Collocation of the MOX Fuel Fabrication Facility as a new building is an option.
- SRS—Construct the PDCF as a new building adjacent to the Actinide Packaging and Storage Facility (APSF), so as to share some common functions with that building. The APSF is a planned facility designed to receive, store, stabilize, and can plutonium metal and oxide. Collocation of the MOX Fuel Fabrication Facility and/or the Immobilization Facility as a new construction adjacent to the APSF are options.
- INEEL—Construct the PDCF in the Fuel Processing Facility (FPF) located at the Idaho Chemical Processing Plant. FPF is an existing hardened building that has never been used. If sited at INEEL, the PDCF would be collocated with the MOX Fuel Fabrication Facility. FPF can only accommodate the PDCF, so the MOX Fuel Fabrication Facility would have to be built as new building.
- Hanford Site—Construct the PDCF in the Fuels and Material Examination Facility (FMEF). FMEF is an existing building that was never used. The PDCF could occupy the bottom three levels of the six-level building. Either the MOX Fuel Fabrication Facility or the Immobilization Facility could be located at Hanford and could be located in the FMEF with the PDCF. Construction of the MOX Fuel Fabrication Facility as new construction adjacent to the FMEF is also an option.

Preliminary layouts of the PDCF were generated for each candidate site and used to prepare life-cycle cost estimates for each of the sites to aid the DOE effort in site selection.

The location of the PDCF is expected to be determined by the SPD EIS ROD. Data reports have been prepared giving the impact of construction and operation of the PDCF at each candidate site. The data reports support the preparation of the SPD EIS. A draft SPD EIS is scheduled to be released early in the summer of 1998, with the ROD scheduled for early in calendar year 1999.

Given the status of decision-making documentation at the time this document is being written, site-specific costs and information will not be given. Additional information may be included at the presentation paper, if release of the information is consistent with SPD EIS progress.

Results

The PDCF is designed to handle 35 metric tons of plutonium metal as pits and metal parts over 10 years of operation. The PDCF will contain all the systems required for removing plutonium from weapon components and package the material into a form acceptable for plutonium disposition. The PDCF includes hardened space, a thick-walled concrete building that houses the plutonium processing activities. Activities needed to support the plutonium processing are housed in space adjacent to the hardened building or housed elsewhere on the site.

The PDCF includes space for the following process activities and support space.

process activities

- pit receiving, storage, and preparation
- pit disassembly
- pit conversion
- oxide blending and sampling
- nondestructive assay (NDA)
- product canning
- product storage, inspection, and NDA by the International Atomic Energy Agency
- product shipping
- non-SNM parts declassification
- HEU decontamination, packaging, storage, and shipping
- tritium capture, packaging, and storage
- waste packaging, assay, and certification

support space

- offices
- change rooms
- central control room
- laboratory
- mechanical equipment rooms
- operator training and process demonstration
- mechanical shops
- emergency generator

- warehouse
- guard stations
- entry portals
- parking

As a new building, the facility has a hardened building plot space of approximately 6500 m^2 (70 000 ft^2). The process area and vaults are located on a single floor below grade, and support functions and utilities are located on a second floor at grade. Offices, change rooms, an analytical laboratory, and other support space are housed in a 3250 m^2 (35 000 ft^2) wing of lesser construction on the floor at grade. The total estimated cost for the facility is approximately $350M, with design costs at approximately $47M. Life-cycle costs for a new building are in the neighborhood of $1B. Staffing for operations is estimated at 400 workers.

Path Forward

OFMD is pursuing a design-only funding approach for the PDCF. A design-only conceptual design report (DOCDR) has been prepared and validated to secure preliminary and detailed design funding. The preliminary design will be used to support the request for construction funding. This approach leads to the following schedule.

Activity	Duration month/calendar year
Facility Preliminary Design	02/1999–10/1999
Facility Detailed Design	10/1999–03/2001
Construction Phase	10/2000–04/2004
Startup	10/2003–3/2005
Operation Phase	3/2005–3/2015

An announcement soliciting AE services for preliminary and detailed design was made in the Commerce Business Daily in March 1998. Selection of the AE is a Brooks Act process and selection of the A/E is anticipated in September 1998. The DOE anticipates awarding one cost-plus contract covering preliminary and detailed design of the PDCF with an option for supervision and inspection of construction.

Preliminary design cannot start in earnest until the SPD EIS ROD. Successful completion of NEPA activities is critical to maintaining the PDCF schedule.

References

(1) President Bill Clinton, "US Nonproliferation and Export Control Policy," Presidential Decision Directive-13 (September 23, 1993).

(2) President Bill Clinton, "United States Policy on Improving Nuclear Material Security in Russia and Other Newly Independent States," Presidential Decision Directive-41 (September 20, 1995).

(3) Department of Energy, " Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement," DOE/EIS-0229 (December 1996).

(4) Federal Register, "Record of decision for the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement," 62 FR 3014 (January 14, 1997).

(5) Dave Curtis, Advanced Recovery and Integrated Extraction System Source Term Fact Sheet," Los Alamos National Laboratory document LA-CP-97-93 (1997).

(6) Lowell Christensen, et al., "Process Logic Flow Diagram for Pit Disassembly and Conversion for Fissile Material Disposition," Los Alamos National Laboratory document LA-UR-97-753 (1997).

(7) Dave Curtis, " Exposure Minimization/Layout Optimization," Los Alamos National Laboratory document LA-UR-97-2208 (1997).

(8) John Darby, John Kindinger, Desmond Stack, " Technical Risk Assessment for the Department of Energy Pit Disassembly and Conversion Facility," Los Alamos National Laboratory document LA-UR-97-2236 (1997).

(9) Lowell Christensen, Charles Richardson, Stanley Zygmunt, "Design-only Conceptual Design Report for the Pit Disassembly and Conversion Facility - Project No. 99-D-141 for the Department of Energy Office of Fissile Materials Disposition (OFMD)," Los Alamos National Laboratory document LA-13398-MS (1997).