Interim Action Determination

Flexible Manufacturing Capability for the Mixed Fuel Fabrication Facility (MFFF)

The Department of Energy (DOE) is preparing the Surplus Plutonium Disposition Supplemental Environmental Impact Statement (SPD SEIS), DOE/EIS-0283-S2. DOE is evaluating, among many other things, the environmental impacts of any design and operations changes to the MFFF, which is under construction at the Savannah River Site near Aiken, South Carolina. DOE evaluated the impacts of construction and operation of the MFFF in the Surplus Plutonium Disposition Environmental Impact Statement (EIS) [DOE, 1999]. DOE currently expects to complete the final SEIS early in Calendar Year 2012. DOE and the MFFF contractor, Shaw-Areva MOX Services, are pursuing utility customers for mixed oxide (MOX) fuel. At the present time, there are agreements with some utilities to investigate the use of MOX fuel. The eventual fuel sales agreement with the utilities will be in place as soon as practical; however, fuel delivery is contingent upon Nuclear Regulatory Commission licensing for the individual reactors. To help ensure the use of MOX fuel in power reactors, which will render the plutonium unusable for nuclear weapons, DOE and Shaw-Areva MOX Services need the capability to manufacture fuel suitable for the variety of reactor technologies that exist in the current United States fleet and to provide the flexibility to manufacture fuel for the next generation of power reactors.

DOE proposes to modify the design of the MFFF to provide the capability to manufacture a variety of fuel types, and to make the design changes and begin the physical modifications required to do so prior to completion of the SPD SEIS. DOE regulations for implementing National Environmental Policy Act (NEPA), at Title 10 Code of Federal Regulations (CFR) Parts 1021.104 and 1021.211, describe requirements for allowable interim action concerning a proposal that is the subject of an ongoing project-specific EIS. No action concerning such a proposal may be taken if the action would: (1) have an adverse environmental impact, or (2) limit the choice of reasonable alternatives.

Proposed Action

DOE proposes to modify the MFFF design to allow the flexibility necessary to manufacture fuel for a variety of reactor designs. The modifications would provide the MFFF with the capability to produce fuel for boiling water reactors (BWR) and next-generation light water reactors, in addition to the current capability for manufacture of pressurized water reactor (PWR) fuel.

The proposed action would entail minor changes to design or operations for PuO_2, UO_2 powder, additives, or feed material preparation, including aqueous polishing and fuel pellet fabrication.

The proposed action involves design changes and modifications to mechanical operations in the manufacturing process portion of the MFFF. The fuel rod fabrication and fuel bundle assembly equipment would be modified to allow for processing fuel pellets and fuel rods of different diameters and lengths to give the MFFF the flexibility to manufacture fuel assemblies of several different designs. Low enriched uranium oxide and low enriched uranium oxide fuel containing gadolinium oxide would be fabricated by a fuel vendor and supplied to the MFFF as complete fuel rods. These rods would be stored in the secure warehouse or in the rod storage racks in the MFFF until needed. The rod processing equipment, including the welding equipment, would also require modifications to accommodate different fuel types.

Physical modifications to the Fuel Assembly Loading Unit and the Assembly Fabrication Unit would be required to accommodate the longer BWR fuel rods and assemblies (compared to PWR rods and assemblies), and to provide space and flexibility to handle rods and assemblies of different lengths. These modifications include removing a structural wall (not a shielding wall) and, because of the grid design change discussed below, reducing or eliminating shielding.

In concert with the design change to allow manufacturing of fuel of various dimensions, the method of inserting fuel rods into the fuel assembly grid would be changed from a keyed grid design to a non-keyed grid design. In a keyed grid, each opening in the grid that a rod would go through is "unlocked", allowing insertion of the rod; after the rod is in place, it is "locked" which tightens the grid around the fuel rod and holds it in place. This design requires an operator to unlock and lock the openings, and manually push rods into the assembly grid one by one. With an unkeyed grid design, this operation is automated, and the rods are pushed or pulled through a tight grid, overcoming friction. The design change from a keyed to a non-keyed grid allows the amount of radiation shielding required to protect workers to be reduced or eliminated. The change in grid design is not required to manufacture BWR or other fuel types, but is proposed along with the other design changes.

The process of loading fuel rods in the assemblies using the unkeyed grid design could generate some fine alloy material, referred to as zirconium fines because of the alloy composition. The quantity of fines per fuel assembly is dependent on the length and diameter of the fuel rods and the number of rods per assembly. For example, a PWR assembly with a 17 by 17 grid has 264 rods, while a 10 by 10 BWR assembly has 91 rods. If the generation of fines is normalized to fines generated per kilogram of Pu processed, there is likely no difference between PWR and BWR assemblies.

The need to store a variety of fuel assembly designs would necessitate a number of changes to the assembly storage area within the MFFF. For example, the quantity of assemblies that would need to be stored to meet a BWR reload batch, estimated to be 132 assemblies, is greater than the PWR reload requirement, estimated to be 36 assemblies. The planned capacity for fuel storage is 456 BWR assemblies or 114 PWR assemblies. Mechanical design changes would be required to handle assemblies of different dimensions, the ventilation design would be modified to accommodate a greater heat release, and radiation shielding panels would be required to protect personnel. DOE and the contractor would also work with the NRC to determine if an increase in the material possession limits in the current facility license application may be required. In addition, criticality calculations would be reviewed, revised as necessary, and storage configurations revised as needed.

Existing Analysis

Environmental impact analysis of the MOX fuel manufacturing process in the SPD EIS is based on data provided in Los Alamos 1998. The executive summary of Los Alamos 1998 states:

> "The MOX facility is designed to fabricate plutonium-uranium mixed oxide fuel for light water reactors (LWRs) at a rate of 3.5 metric tons (MT) Pu metal/yr in order to dispose of 35 MT Pu metal over a nominal 10-year period. Both boiling water reactor (BWR) and pressurized water reactor (PWR) fuel pellets, rods and assemblies may be manufactured, and additional space has been provided for the possible production of other fuel types (e.g., CANDU)."

Furthermore, the Overall Assumptions (Appendix A.3, p. A-2) include:

> "The data provided to support the preparation of the EIS will have built-in margins to allow flexibility in actual facility design and layout. The margins are not likely to materially alter the findings presented in the data call report."

and

> "The final design and layout of the MOX FFF depends on the process technology selected for the MOX mission as detailed in the PAS [Program Acquisition Strategy]. This selection is currently scheduled for August 1998, at the earliest. Therefore, a preconceptual MOX FFF layout is provided to support the preparation of this data call report."

The preconceptual layout appears as Figures 2-14 and 2-15 in the SPD SEIS.

The impact assessments in the SPD SEIS are based on disposition of 3.5 MT per year plutonium metal and the use of 99 MT per year depleted or natural uranium, depending on fuel production and design requirements. The total heavy metal production is based upon producing twice the amount of PWR as BWR fuel where PWR enrichment is 4.29 weight percent Pu, and the BWR enrichment is 2.97 weight percent enrichment (Los Alamos 1998). The analysis also assumes that enriched UO_2 fuel rods or pellets may be required as part of the fuel rod and bundle fabrication, if bundle design requires a mix of MOX and enriched UO_2 rods or pellets. The maximum amount of enriched UO_2 required is assumed not to exceed twice the MOX fuel. The amount of enriched uranium fuel required at the MFFF depends on the actual fuel bundle design, which was not established when the data call document was prepared (Los Alamos 1998).

Environmental Impacts

All the fuel manufacturing and storage modifications required to provide the desired manufacturing flexibility would take place within the current footprint of the MFFF. The SPD SEIS impact analysis was based on a preconceptual facility layout and a set of assumptions which served to describe a facility capable of manufacturing a variety of MOX fuel types, including specifically PWR and BWR fuel. The information in Los Alamos 1998 was based on a preconceptual layout and a set of assumptions that describe a facility to manufacture up to 3.5 MT of surplus Pu per year into MOX fuel of various designs, with margins to allow flexibility in actual facility design and layout. No aspect of the proposed action is outside of the envelope described and evaluated in the SPD SEIS, which was based on Los Alamos 1998.

Shaw-Areva MOX Services has prepared a Preliminary Evaluation for the Fabrication of BWR Reactor Fuel (Shaw-Areva, 2010). The information presented is necessarily qualitative; preparation of quantitative data must await approval of a Baseline Change. This preliminary evaluation compares the current design, for manufacturing PWR fuel, to the proposed flexible design. The preliminary evaluation includes the following conclusions:

- No new accident sequences are identified;
- The existing safety analyses, including worker protection, normal releases, and event scenarios bound any greater quantity of uranium that would be in the building to accommodate manufacture of BWR fuel;
- The existing load handling and criticality analyses may have to be updated to demonstrate that the existing analyses bound the potential impacts of BWR fuel manufacture;
- Eliminating shielding in the fuel assembly area will not increase the radiological dose rate to the operators; and
- Proposed changes in mechanical operations are consistent with the overall facility design basis, the license application safety strategy, and the applicable safety analyses.

DOE evaluated the impacts of a MFFF that would manufacture multiple fuel types in the SPD EIS. Preliminary analysis shows that impacts of modifying the design and operating the facility to manufacture a variety of fuel types are bounded by existing safety analyses, and no potentially adverse impacts have been identified. The proposed modifications would have no effect on DOE's selection of alternative plutonium preparation or disposition alternatives following completion of the SPD SEIS, because the type of fuel ultimately manufactured does not depend on the selection of a particular alternative. Therefore the proposed design modifications of the MFFF are a clearly allowable interim action in accordance with DOE's NEPA regulations.

Approved at the Savannah River Site, Aiken, South Carolina, APR 01 ____, 2011

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References

DOE (U.S. Department of Energy), 1999. Surplus Plutonium Disposition Final Environmental Impact Statement. Office of Fissile Materials Disposition, Washington, DC. November 1999.

Los Alamos (Los Alamos National Laboratory), 1998. Response to the Surplus Plutonium Disposition Environmental Impact Statement Data Call for a Mixed Oxide Fuel Manufacturing Facility Located at the Savannah River Site. LA-UR-97-2066. Technology and Safety Assessment Division, Los Alamos National Laboratory. June 22, 1998.

Shaw-Areva MOX Services, LLC. 2010. BCP#10-040 Preliminary Evaluation for the Fabrications of BWR Reactor Fuel. MOX Fuel Fabrication Project PP8-6 Evaluation Form. September 2010.