UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

September 27, 2010

The Honorable Gregory B. Jaczko
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: LICENSE APPLICATION FOR THE MIXED OXIDE FUEL FABRICATION FACILITY AND THE ASSOCIATED SAFETY EVALUATION REPORT

Dear Chairman Jaczko:

During the 575th meeting of the Advisory Committee on Reactor Safeguards, September 9-11, 2010, we reviewed the NRC staff's draft Safety Evaluation Report for the Mixed Oxide Fuel Fabrication Facility (MFFF) license application. The staff is seeking our endorsement of their evaluation of the license application to possess and use special nuclear material. Our Subcommittee on Siting met August 19-20, 2010, to discuss this evaluation with the staff and with representatives of MOX Services, LLC. We also had the benefit of the documents referenced.

CONCLUSION AND RECOMMENDATION

1. The staff has prepared an adequate Safety Evaluation Report for the Mixed Oxide Fuel Fabrication Facility and the report should be issued.

2. The proposed facility can be constructed, operated, and maintained with no undue risk to the public health and safety.

BACKGROUND

The MFFF will convert weapons-grade plutonium dioxide into mixed oxide fuel for use in commercial, light water, nuclear power plants. The facility is being built on the Savannah River Site for the U.S. Department of Energy (DOE) in pursuit of a national policy to reduce the country's inventory of weapons-grade plutonium. The facility is being constructed and will be operated by a private entity, MOX Services, LLC, for the DOE. The U.S. Nuclear Regulatory Commission will license, inspect, and monitor the facility.

The MFFF will receive feeds of plutonium dioxide from the DOE and return wastes to the DOE for final disposition. The facility will use an aqueous process to purify the feed material of small amounts of americium and gallium. The product plutonium will be converted to an oxide. The purified oxide will be used, then, to fabricate mixed oxide fuel assemblies suitable for use in commercial, light water, nuclear power plants.

The strategy for processing the plutonium feeds is patterned after an aqueous processing system used in France for the reprocessing of spent nuclear fuel and builds upon the substantial experience in this country with the use of the PUREX process for fuel reprocessing. The

aqueous system is substantially simpler than that used for spent fuel reprocessing since the feed material will not be contaminated with large inventories of diverse fission products and neutron capture products. The system is also very much smaller than usual fuel processing facilities since the total plutonium throughput is expected to be less than 40 metric tons.

The fabrication of nuclear fuel from the purified plutonium dioxide is also patterned after an established mixed oxide fuel fabrication process used in France.

We have discussed this facility in our February 24, 2005, report to you on our review of the staff's Safety Evaluation Report of the Construction Authorization Request. In that report, we highlighted the need for the license application to address criticality, hydroxylamine nitrate, the "red oil" phenomenon, and glove box fires.

DISCUSSION

The principal safety hazards that could affect the public health and safety arise primarily from the potential for energetic events such as nuclear criticality and fire. Energetic events might disperse plutonium, americium, and uranium into the environment. The facility has been designed using established precautions against nuclear criticality including scrupulous observation of the so-called "double contingency" principle. There is adequate shielding and filtration to protect the public from prompt effects should there be a nuclear criticality event.

Precipitation of plutonium hydroxide from tetravalent plutonium solutions with insufficient acid concentration is a possible, but less familiar, cause of criticality events. Empirical evidence suggests that the precipitation of plutonium hydroxide can be avoided if nitric acid concentrations are kept above a minimum (~0.5 molal). MOX Services has used chemical modeling to justify their administrative limit (~0.75 molal).

The staff's safety evaluation of the potential for criticality events at the MFFF was based on sampling and in-depth evaluation of selected aspects of the safety strategy. The selection of systems to examine in detail was judicious, and the detailed examinations were adequate.

There are a multitude of potential accidents involving fire at the facility. The aqueous processing strategy involves the extraction of plutonium from acid solution into an alkane phase using tributyl phosphate as a chelating agent. There is, then, a potential of fire involving the organic solvent. The extraction of plutonium and the stripping of plutonium from the organic phase involve valence state changes produced by strong oxidants and reductants. Incautious use of these reagents can, of course, lead to fires and even explosions. The facility is also susceptible to explosive events involving the infamous "red oil" phenomenon.

Where possible, the facility safety systems have been designed using quantitative and even mechanistic models of possible hazardous chemical processes. Certainly, this has been the case with regard to the autocatalytic reactions of hydroxyl amine nitrate. When the needed phenomenological understanding is not available, such as with the "red oil" phenomenon, facility safety has been based on administrative measures, mitigation, and defense in depth. In this regard, the facility has fully incorporated the recommendations to protect against "red oil" events made by the Defense Nuclear Facilities Safety Board and has gone beyond these recommendations in several respects.

In the preparation of their Safety Evaluation Report, the staff has very thoroughly reviewed the analyses of chemical phenomena and implementation of administrative limits. Our examinations of these safety strategies revealed no deficiencies.

A persistent issue in work with plutonium materials is the potential for fires in glove boxes. The applicant has effective strategies for the prevention, detection, and suppression of fires in the glove box areas. Suppression relies on chemical fire suppressants that do not assure that the fire is finally extinguished. The applicant proposes to rely on response by the experienced Savannah River Site fire department to assure any fires are finally extinguished. This interface with the Savannah River Site fire department is not fully established, but there is a clear pathway for this to occur.

Fires involving the zirconium alloy cladding used for fuel fabrication in the facility are possible. The applicant is using industrial standard practices that have proved effective in the past to prevent fires of this type.

As required by regulation, the applicant submitted an Integrated Safety Analysis Summary. The Integrated Safety Analysis is thorough. It is being used in the design process and has led to the identification of needed Items Relied on For Safety (IROFS). The staff review of the Integrated Safety Analysis revealed some additional IROFS.

Facility operations may be interrupted by either insufficient supply of plutonium feed or inability of the DOE to receive facility wastes. The facility has been designed to accommodate such interruptions and avoid storage of plutonium solutions in process lines for objectionable periods.

Because of the extensive measures taken to limit the potential for criticality and fire events, we are confident that the proposed MFFF can be constructed, operated, and maintained with no undue risk to the public health and safety. The Safety Evaluation Report prepared by the staff is adequate and should be issued.

Protection of the workforce at the facility is, of course, an important issue. In this regard, Breathing Zone or Lapel Air (BZA) sampling is an excellent adjunct to fixed head area air sampling, where airborne plutonium during normal and adverse conditions is possible. Fixed air sampling is often less representative of inhaled material. BZA sample data are also more sensitive than bioassay data and are available in a more timely way, making dose assessments more timely and effective for evaluating workplace radiological controls.

The regulatory process requires that construction of the facility be verified by inspection prior to granting a license to possess and use special nuclear material. Changes will no doubt occur as the construction process proceeds. We therefore look forward to an opportunity to revisit the safety evaluation of the MFFF as construction approaches completion, to review any revisions to the facility's license application and to examine the staff's evaluation of the revisions.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

References:

1. Draft Safety Evaluation Report for the License Application to Possess and Use Radioactive Material at the Mixed Oxide Fuel Fabrication Facility in Aiken, South Carolina, July 2010 (ML1022801911)

2. Shaw AREVA MOX Services, "MFFF—License Application," Aiken, SC, March 2010 (ML101040742)

3. Shaw AREVA MOX Services, "MFFF—Integrated Safety Analysis Summary," Aiken, SC, March 2010 (ML101050132 (non-public), ML101050134, ML101050136, ML101050137) (proprietary)

4. U.S. Nuclear Regulatory Commission, NUREG-1718, "Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility," 08/31/2000 (ML003741461)

5. U.S. Nuclear Regulatory Commission, NUREG-1821, "Final Safety Evaluation Report on the Construction Authorization Request for the Mixed Oxide Fuel Fabrication Facility at the Savannah River Site, South Carolina," 03/31/2005 (ML050960447)

6. Letter to Nils J. Diaz, Chairman, "Review of the Final Safety Evaluation Report for the Mixed Oxide Fuel Fabrication Facility Construction Authorization Request," 02/24/2005 (ML050550254)

7. Defense Nuclear Facilities Safety Board, "Control of Red Oil Explosions in Defense Nuclear Facilities," (DNFSB/TECH-33), Washington, DC, 11/13/2003 (Available online at: http://www.dnfsb.gov/pub_docs/technical_reports/all/tr_20031113.pdf)

8. IAEA Draft Document, Safety of Nuclear Fuel Cycle Facilities, October 2005 (Available online at: http://www.sefidvash.net/fbnr/pdfs/INPROFuelSafety.pdf)

9. Brookhaven National Laboratory, "Red Oil Excursions in the Mixed Oxide Fuel Fabrication Facility—Overview and Summary Report," 08/28/2009 (ML092250625)

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