DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004-2901
(202) 694-7000

July 10, 2000

The Honorable Carolyn L. Huntoon
Assistant Secretary for
Environmental Management
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Dr. Huntoon:

The staff of the Defense Nuclear Facilities Safety Board (Board) visited Oak Ridge National Laboratory on May 4–5, 2000. During that visit, they reviewed equipment design and safety analysis for remediation work for the Molten Salt Reactor Experiment (MSRE). This work involves removal of highly radioactive uranium-233 from the facility, an initial step in the remediation program described in the Department of Energy's (DOE) Implementation Plan for Board Recommendation 94-1, *Improved Schedule for Remediation in the Defense Nuclear Facilities Complex.*

The Board's staff has observed a number of safety-related matters relative to the deactivation program for the MSRE. A Board staff report identifying them is enclosed for DOE consideration and disposition.

The Board did not include the MSRE deactivation in its Recommendation 94-1. The Secretary of Energy did, however, include it in his implementation plan for Recommendation 94-1 and the Board's staff has undertaken some reviews of it to date. Notwithstanding, the MSRE is not considered by the Board to be a defense nuclear facility. Henceforth, the Board does not intend to perform further reviews of its deactivation.

Sincerely,

John T. Conway
Chairman

c: Ms. Gertrude Leah Dever
Mr. Mark B. Whitaker, Jr.
Mr. Earl Leming

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

May 26, 2000

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: H. W. Massie

SUBJECT: Preparations for Stabilization of Materials at Molten Salt Reactor Experiment

This report documents a review performed by the staff of the Defense Nuclear Facilities Safety Board (Board) of the equipment design and safety analysis for remediation work at the Molten Salt Reactor Experiment (MSRE). This review was conducted during a visit to Oak Ridge National Laboratory (ORNL) on May 4–5, 2000, by staff members H. W. Massie, D. Winters, D. Moyle, and L. Zull.

Background. Although MSRE is not a defense nuclear facility under the Board's jurisdiction, the Department of Energy (DOE) decided to include remediation activities at MSRE in its Implementation Plan for the Board's Recommendation 94-1, *Improved Schedule for Remediation in the Defense Nuclear Facilities Complex.* The MSRE project is now managed by Bechtel-Jacobs, replacing Lockheed Martin Energy Research.

Since 1994, the DOE Oak Ridge Operations Office (DOE-ORO) has continued to reduce the safety risks at MSRE. These efforts have included draining water from the charcoal bed cell to reduce criticality risks, denaturing the carbon fluorides contained in the auxiliary charcoal bed (ACB), and removing reactive gas (i.e., uranium hexafluoride [UF_6]) within the MSRE system. The major remaining risk reduction activities are to remove 2.6 kg of solid uranium-233 (U-233) deposits from the ACB, convert recovered UF_6 to stable uranium oxide, and remove and stabilize fuel salts from two storage tanks. The Recommendation 94-1 milestones are to perform the first of these items by December 2000 and all the remaining work by May 2002. DOE plans to conduct two evolutions in 2000: (1) to remove the solid uranium deposits from the ACB, and (2) to convert UF_6 to stable uranium oxide. Both are high-hazard activities.

Uranium Deposit Removal. The ACB is a 6 in. diameter schedule 10 pipe, 80 ft long and shaped as two "U" bends. The U-233 is deposited in the top 12 in. of one ACB leg. In April 1998, ORNL denatured the fluorinated charcoal within the ACB with ammonia to prevent possible deflagrations. Previous attempts to retrieve the U-233 deposit had been unsuccessful because the charcoal medium was not in a granular form as expected, but was a hardened mass. The new plan is to cut off the top cap of the ACB pipe and to use an assortment of tools to break up the charcoal and vacuum out the U-233 deposit. Equipment fabrication is approximately 80 percent complete.

Before cutting off the top of the ACB, ORNL will conduct a second denaturing operation using a mixture of ammonia and helium to eliminate reactive compounds before the deposit is broken up manually. The staff is concerned that ORNL has not demonstrated that the ammonia will sufficiently penetrate the hardened charcoal. The staff believes the controls for this activity need to be reassessed.

The primary hazards for the uranium deposit removal project are as follows: deflagration during ACB cutting and charcoal breakup, hydrogen generation caused by radiolysis of ammonium fluoride, contamination releases, and very high radiation dose rates (500 R/hr on contact). ORNL identified controls for all of these hazards, but some, such as the effectiveness of denaturing to prevent deflagration during charcoal breakup, require additional scrutiny. ORNL plans to purge the equipment and ACB area with helium to keep hydrogen concentrations below the lower flammability limit.

ORNL did not identify the need for any safety-significant or safety-class items in the safety analysis conducted for MSRE. The highest-consequence accident postulated for this activity in the MSRE authorization basis (i.e., Basis for Interim Operation) is a deflagration of the fluorinated charcoal. This accident has a calculated maximum dose to the public (less than a mile away) of less than 5 rem. Worker hazards could be much greater, and the staff believes that safety-significant equipment may be warranted to protect workers from severe accident scenarios (e.g., deflagrations, exposure to high dose rates).

Uranium Hexafluoride Conversion. Reactive UF_6 gas was removed from MSRE from late 1996 through early 1998 and stored on 25 sodium fluoride (NaF) traps. Twenty-three of the traps are stored in the Building 3019 tube vault; 2 are stored in Cell 1 of Building 3019 for gas pressure monitoring. Pressure continues to build up in the traps as a result of radiolysis of the UF_6, forming fluorine gas. Monitored traps show a pressure buildup of 160 psig during the last 2 years, and the most limiting trap is not monitored. The design pressure of the traps is 800 psia. ORNL plans to start removal of the traps in October 2000, and to convert the UF_6 to uranium oxide in a hot cell in Building 4501. Because of the continuing pressure buildup in the traps, this project has the highest priority of the MSRE remediation work.

Equipment fabrication is about 90 percent complete. ORNL installed the equipment in a semimodular mockup facility in the high bay area of Building 4501. Bench-scale prototype tests have been conducted using NaF traps containing depleted UF_6. The UF_6 will be converted to U_3O_8, heated to a high stabilization temperature, and packaged to meet the new U-233 storage standard.

ORNL presented preliminary results of the Building 4501 hazard and safety analysis for the uranium conversion project. Building 4501 is designated as a "radiological" hazard category facility, but the conversion project is Hazard Category 2, based on the amount of U-233 in a single NaF trap. ORNL submitted a draft Safety Analysis Report and Technical Safety Requirements to DOE in June 1999. DOE's comments are currently being resolved.

Bechtel-Jacobs will give UT-Battelle (operator of Building 4501) a work authorization to conduct the conversion project, but intends to maintain responsibility for the project's authorization basis. The staff believes it would be more appropriate for UT-Battelle to have responsibility for the authorization basis, since the conversion work will be done in a UT-Battelle facility. This issue needs to be resolved promptly.

ORNL plans to remove the NaF traps one at a time from Building 3019, and to ship each trap to Building 4501 in a 6000 lb shielded carrier. ORNL's accident analysis showed that the worst-case accident is a large facility fire that overheats the transport carrier, causing the NaF trap to fail, and expelling the UF_6 gas to the building and then out of the top of the building. Assuming 2 kg of U-233 (instead of about 1 kg expected on the worst-case trap), ORNL calculates a maximum public dose of 20 rem. ORNL could not identify any safety controls to mitigate this accident since the transport cask is not sealed and is too heavy to be moved readily out of a burning facility. The staff suggested possible controls, such as fire watches, combustible material controls, crane maintenance to provide the ability to remove the cask quickly, and/or sealing of the transport cask.

DOE plans to conduct an Operational Readiness Review for this work in early fall 2000. The staff believes substantial work is required to provide adequate controls for the hazards identified.

Disposal of Uranium-233 Deposits. Bechtel-Jacobs is evaluating the feasibility of disposing of the U-233 deposit to be removed from the MSRE ACB in the Waste Isolation Pilot Plant (WIPP), as remote-handled transuranic (RH-TRU) waste. Whether the waste to be disposed can be classified as defense waste on the basis of the small plutonium fraction present has yet to be determined. There is also a concern that ongoing fluorine gas generation by the waste may cause it to fail to meet the WIPP Waste Acceptance Criteria. Lastly, even if the waste is proven eligible for disposal at WIPP, that facility has not yet received approval from the State of New Mexico for any future receipt of RH-TRU. Unless the Resource Conservation and Recovery Act Permit for WIPP is modified to allow RH-TRU disposal, the facility will only be able to continue to receive contact-handled TRU waste. Bechtel-Jacobs plans to work with the DOE Carlsbad Area Office and other cognizant organizations to determine definitively whether the waste can be disposed at WIPP. If not, ORNL will likely be required to store this waste on site for an indefinite period, since there is no other currently identified path for disposal.

Equipment Procurement and Quality Assurance. The staff reviewed a sampling of the quality assurance and quality control records for the conversion equipment, and found them to be in good order. ORNL fabricated the majority of the equipment using on-site shops. The conversion vessel has traceability of material heat numbers, certified material test reports, nondestructive examination test reports, weld inspection reports, and change control documentation. The conversion vessel is designed to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section VIII, Division 1, and the vessel welds were made in accordance with American Welding Society standards.