DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004
(202) 208-6400

March 18, 1998

The Honorable Ernest J. Moniz
Under Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Dr. Moniz:

The Defense Nuclear Facilities Safety Board (Board) has consistently encouraged the Department of Energy (DOE) to address the urgent need for removal of the deteriorating spent nuclear fuel from the K-Basins at the Hanford Site and for provision of stable interim storage of the spent fuel on site. In response to Board Recommendation 94-1, DOE concurred and committed to begin removal of the spent fuel by December 1997. A letter from the Board to DOE dated November 18, 1997, addressed concerns about extensive delays in the schedule for placing the spent fuel in safe interim storage, and requested a report describing DOE and contractor plans for the path forward for the Spent Nuclear Fuel Project (SNFP).

In a letter dated December 31, 1997, DOE advised the Board that these concerns were shared, and that a report would be provided before the end of March 1998. The Board recognizes that the DOE-Richland Operations Office (DOE-RL) and the contractors are continuing to give increased management attention to the SNFP and that personnel and organizational changes have recently been made on the project. The Board was briefed by DOE-RL (C. Hansen) on problems limiting the progress of the project. Mr. Hansen recognizes that a firm commitment by DOE to revised and realistic dates for meeting the 94-1 Implementation Plan milestones is urgently needed. Towards such end, the Board offers the following.

During a recent visit to the site, the Board's staff reviewed the SNFP technical strategy to adopt a sealed container for initial storage of the spent fuel, based on more realistic bounding conditions related to container pressurization. A report on the staff's visit is enclosed for your consideration. The Board sees no barriers to proceeding with DOE's technical strategy to seal the fuel containers after cold vacuum drying. Reduction of unnecessary conservatism in design and analysis should be considered when possible to enhance schedule performance and reduce costs. As stressed by the Board in the past, prompt attention to resolution of emerging technical issues based on a balance of needs will contribute to the safe, expeditious initiation of fuel removal.

The Board requests that the DOE report expected in March 1998 address the Board staff observations in the attached memorandum as well as those issues previously identified by the Board relative to the SNFP.

Sincerely,

John T. Conway
Chairman

c: Mr. John Wagoner
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

DNFSB Staff Issue Report

February 18, 1998

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: D. Wille

SUBJECT: Spent Nuclear Fuel Project Review at the Hanford Site

This memorandum documents a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the Department of Energy's (DOE) Spent Nuclear Fuel Project (SNFP) at the Hanford Site. The review covered the implementation of the sealed strategy for the multicanister overpacks (MCOs) and was conducted during the period February 3–5, 1998, by staff members D. Wille, D. Grover, J. Roarty, and W. Yeniscavich. Site representatives P. Gubanc and D. Ogg assisted during the visit.

Schedule Recovery for Initiation of Fuel Retrieval. A noticeable omission in the SNFP is an apparent lack of emphasis on initiating fuel movement from the K-Basins as soon as possible. The guidance contained in Board Recommendation 95-2 to tailor requirements offers the potential for schedule recovery, as the consequences associated with most of the hazards or upset conditions involved in spent fuel retrieval, processing, and storage are relatively minor.

In addition, the assignment of ultimate safety responsibility to a single manager who must balance competing interests such as mission, safety, and budget does not appear to have occurred at the SNFP. The leadership role for safety analysis activities within Duke Engineering and Services Hanford (DESH) is now assigned to an individual reporting to the Chief Engineer, who reports to the Project Director. Fluor-Daniel Hanford (FDH) has also established a three-person team to provide an interface between the DOE-Richland Operations Office (DOE-RL) Safety Analysis Report (SAR) review team and the SAR preparers at DESH. DOE-RL has added another individual to coordinate their review team responses. The proliferation of individuals who manage and coordinate the safety review effort could interfere with effective and timely preparation of the required safety documentation.

Sealing of MCO After Cold Vacuum Drying. The recent concept for dry storage of the spent nuclear fuel from the K-Basins was to put the fuel in a stainless steel container (MCO) with pressure relief devices, and handle and store the containers within an inert gas environment in the Canister Storage Building (CSB) prior to hot conditioning. This concept was based on overly conservative calculations that predicted the development of high hydrogen gas pressures within the MCO during storage and the potential for escape of hydrogen to the environment. The equipment needed to implement this concept was complex and expensive to design and build, and also complex to operate. As more data demonstrating the excessive conservatism used in the original calculations became available, the current strategy to seal the MCOs without pressure relief after cold vacuum drying (CVD) and eliminate the hot conditioning step was developed.

Overall, the calculations and assumptions showing that the MCO can be sealed after CVD without overpressurizing appear reasonable and correct to the Board's staff. Confirmation of these predictions, however, can be made only by monitoring the internal gas pressure in the MCOs as they age. If the calculations are in error or some novel gas-generating phenomenon was overlooked, periodic pressure relieving of the MCOs will be required until the reactants are consumed. Some reviewers of the current sealing strategy have criticized details of the calculations, and have requested more characterization data and additional refined calculations before the operations proceed. However, the Board's staff believes refinements to the model based on additional characterization would not add much to the current calculations without causing significant delays to the SNFP schedule. Monitoring of the MCOs as they age would still be required to validate the refined calculations.

The key safety features necessary to support sealing the MCO after CVD are pressure monitoring of the MCOs and the capability to relieve internal MCO pressure, if doing so becomes necessary. Equipment to perform pressure relieving operations in the CSB is planned to be available. The current monitoring plan for the MCOs in the CSB is to measure pressure and gas composition in the first 12 MCOs from the K-West Basin and the first 12 MCOs from the K-East Basin. This monitoring is planned for process validation of the chemical reaction and MCO pressurization models. The remaining 376 MCOs may be monitored either by a simple pressure-measuring device or on a sample basis. The Board's staff believes a statistically based sampling plan is needed for the remaining MCOs. This sampling plan could incorporate the results of the process validation to determine the sampling frequency. Additional reviews of the monitoring plan will be conducted by the Board's staff as the detailed plan is developed.

Aluminum Hydroxide Removal. A tightly adherent coating of aluminum hydroxide that could lead to increased generation of hydrogen during storage has been discovered on some of the spent fuel elements in the K-West Basin. Establishment of the safety basis for pressurization of a sealed MCO is planned based on the determination that the MCO design pressure cannot be exceeded, even when no aluminum hydroxide removal is credited. This approach is enhanced by increasing the design pressure from 150 to 450 psig with design changes to the MCO, i.e., adding 1/4" thickness to the base of the container and changing to a higher-strength material for the threaded extension of the shell. The availability and weldability of higher-strength material to implement this change are potential concerns. The existing MCO design, although rated at 150 psig, is estimated to be capable of meeting a design pressure of 260 psig. This increased pressure is approximately equal to the estimated pressure that could be developed when no aluminum hydroxide removal is credited. Should the above strategies prove unacceptable, removal and inspection techniques to address the aluminum hydroxide coatings will need to be demonstrated.

Welded Cap on the MCO. The MCO will have a mechanical seal in the closure head that will be effective during the CVD process and initial monitoring in the CSB. To provide interim storage (about 40 years), a mechanical seal with a welded cover and weld surface examination only would require constant monitoring to detect leakage past the mechanical seal. This monitoring satisfies Nuclear Regulatory Commission (NRC) requirements and would be consistent with commercial dry storage precedents. To eliminate the need for constant monitoring, it is planned to perform full volumetric ultrasonic testing of the cover weld to ensure weld integrity. The welding and ultrasonic testing will be performed in the hot conditioning pits in the CSB that are no longer needed. Development of the weld and inspection equipment is in progress. The Board's staff questioned the current lack of provision for cutting the weld and removing the cap at a later time, if needed. This ability to access the spent fuel in storage is required by NRC (10 CFR 72.122 (l)) for an independent spent fuel storage installation.

Runaway Reactions in Water-Filled MCOs. Bare uranium metal exposed to water reacts to form uranium oxide while liberating hydrogen and heat. The scrap baskets in an MCO contain many small pieces of exposed uranium fuel, and heat removal is retarded by the insulating effects of the basket, the MCO, and the surrounding transport cask. As the temperature of the fuel increases, the reaction rate increases, generating more heat. This increases the fuel temperature still further, leading to the potential for a runaway reaction. Simple one-dimensional calculations show that a runaway should not occur with the existing limits on the amount of exposed fuel, provided the ambient temperature stays below 75°C. Although these calculations appear reasonable to the Board's staff, they have not been confirmed by operating experience or prototypical experiments.

The potential for a runaway reaction is reduced by minimizing the time water remains in the MCO and by keeping the temperature of the water as low as possible before it is drained. This prudent approach is being followed except for the initial phase of operation in the CVD facility, where the MCO is heated from approximately 20 to 50°C while still full of water. The staff has suggested that the process be revised to remove the water before the MCO is heated to 50°C. This suggestion will be evaluated by the project.

To prevent a runaway reaction, the following measures will be used to prevent the fuel from overheating. During transport, the operating procedures will limit the transfer time between the basins and the CVD facility. During CVD, the design will provide two safety-class features to ensure that MCO cooling remains during upset conditions. The first is a safety-class system to alarm upon loss of the MCO-cask annulus water, which provides for convective cooling of the MCO shell and a heat sink for generated heat. Water would then be injected manually into the annulus from a gravity-fed system. The second safety-class system would inject helium into the MCO in the event of process interruption. This would allow for improved heat transfer from the fuel to the MCO shell once the water had been drained from the MCO. The Board's staff agrees that these features provide defense in depth for these potential events.