DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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February 4, 2005

Mr. Paul M. Golan
Acting Assistant Secretary for
Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Mr. Golan:

The staff of the Defense Nuclear Facilities Safety Board (Board) recently visited the Hanford Site to review the Sludge Retrieval and Disposition Project (SRDP). The mission of the SRDP is to remove, process, and package for disposal approximately 50 cubic meters of radioactive sludge that is present on the floors of the K-East and K-West Basins at Hanford. A report documenting the staff's observations is included as an enclosure to this letter.

The Board notes that the SRDP continues to experience difficulties in design, engineering, and testing. For example, during the course of design and fabrication of the sludge consolidation containers, project engineers had to make several design changes to address issues regarding installation, dose rate, settling and capture of sludge, and planned retrieval of sludge from the containers. The Board believes these continuing design changes are indicative of a lack of fundamental understanding of the properties and characteristics of the sludge. As a result, defining the scope of work of the project is not thorough and planning for the life cycle of the project is incomplete. This in turn is evidence of continuing difficulties with project management, definition of functional requirements, and design.

As the enclosed report notes, there are other indications of continuing design, engineering, and testing difficulties within the SRDP. These difficulties include sludge flocculent not performing as designed for use in the K-East sludge containers; failure of the casing of the hose-in-hose transfer pump during testing as a result of erosion; insufficient consideration of engineered controls during the design of sludge retrieval operations, in particular for the potential increase in airborne radioactivity during sludge-disturbing activities; and a design that does not preclude the possibility of an undetected leak during operation of the Hose-in-Hose Transfer Line. Many of these deficiencies stem from an apparent failure of the core functions of Integrated Safety Management: defining the scope of work, identifying and controlling hazards, and providing feedback for continuous improvement. Personnel from the Department of Energy (DOE) Richland Operations Office have also recognized some continuing difficulties with the project, and have decided to conduct an independent engineering review of portions of the Hose-in-Hose Transfer Line.

Deficiencies in design, engineering, and testing have been documented by several independent reviews of the project and in Fluor Hanford's Broader Scope Issues report of February 2004, which also identified causes and corrective actions for the noted deficiencies. While Fluor Hanford has taken corrective actions in response to these reviews, the continuing problems noted above indicate that these corrective actions may not have been effective. Fluor Hanford has committed to completing a review of the effectiveness of corrective actions identified in the Broader Scope Issues report to address these continuing issues. However, it appears that the system for verifying the effectiveness of corrective actions is inadequate.

The Board is concerned about the continuing difficulties and slow progress of the SRDP. Quality design, engineering, and testing are crucial to safe and efficient equipment operation that minimizes workers' time in hazardous areas and minimizes their exposure to hazardous conditions. Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests that responsible DOE personnel provide a report to the Board within 60 days of receipt of this letter that documents the effectiveness of the corrective actions reportedly in place to address the engineering difficulties of the SRDP. The report should also identify further corrective actions needed in the areas of design, engineering, and testing, as well as steps to be taken to ensure that future corrective actions are reviewed for effectiveness. Additionally, the report should address the noted Integrated Safety Management failures regarding definition of the scope of work, identification and control of hazards, and feedback and improvement.

Sincerely,

John T. Conway
Chairman

c: Mr. Keith A. Klein
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

January 11, 2005

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: M. Feldman and D. Ogg

SUBJECT: Sludge Retrieval and Disposition Project, Hanford Site

This report documents a review of the K-Basins Sludge Retrieval and Disposition Project (SRDP) at the Hanford Site conducted by the staff of the Defense Nuclear Facilities Safety Board (Board) during December 7–9, 2004. Staff members M. Feldman, D. Ogg, and R. Quirk and Site Representative D. Grover discussed aspects of several SRDP subprojects with representatives of the Department of Energy Richland Operations Office (DOE-RL) and Fluor Hanford, Inc. (FH).

Background. The SRDP consists of several subprojects, including sludge retrieval from the K-East Basin North Loadout Pit (NLOP), consolidation of K-East Basin sludge into new containers in the basin, transfer of the consolidated K-East Basin sludge to the K-West Basin via a hose-in-hose transfer line (HIHTL), and removal and treatment of all sludge for disposal as transuranic waste. Under FH's Waste Management Project, NLOP sludge is to be stored at T-Plant, where operators plan to install and operate a grouting system for this sludge stream. Retrieval of NLOP sludge and consolidation of K-East Basin sludge are ongoing. All other subprojects are in varying stages of design, procurement, and construction.

Consolidation of Sludge. The contractor has installed two of the four containers to be used for consolidation of K-East Basin sludge. Consolidation of the sludge has begun in order to clear space for installation of the remaining two containers. During the design and fabrication of these containers, as well as those to be installed in K-West Basin, project engineers had to make several design changes to address issues regarding installation, dose rate, settling and capture of sludge, and planned retrieval of sludge from the containers.

The staff believes these continuing design changes are indicative of poor planning for the life cycle of the project and a lack of integration among subprojects. Consideration of sludge retrieval was relegated to the HIHTL subproject, where the design schedule was not integrated with that for sludge consolidation. Functional requirements were not formally developed and approved until the construction phase of the consolidation subproject. This in turn is evidence of continuing difficulties with project management, definition of functional requirements, and design, and of a failure to adequately define the scope of work as required by Integrated Safety Management.

Additionally, the flocculent system to be used to enhance settling and minimize clouding of the basin water did not perform as expected during testing. After more thorough interaction with outside experts and the vendor, gross conceptual problems were corrected, and the system was redesigned. The effectiveness of the flocculent system is still not well understood, however, and the contractor is currently reevaluating use of the system. Operators began consolidating the K-East Basin sludge into new containers without the flocculent system.

The Board's staff noted the potential for a plume of cesium to form in the basin water during sludge consolidation. Excess cesium entrained in the sludge will be released into the water when the sludge is disturbed, and some sludge and cesium will be forced close to the surface during the consolidation process. This increased cesium content in the water could contribute to higher airborne radioactivity levels. Such an increase in water and airborne radioactivity has been observed during past sludge and fuel processing operations and has caused operational difficulties. The project engineers rely on monitoring and personal protective equipment to protect workers, instead of using engineered and/or administrative controls to mitigate this hazard. Although significant spikes in radioactivity levels have not been observed, the probability of this hazard will increase as consolidation continues and higher-activity sludge is disturbed.

Hose-in-Hose Transfer Line. Contractor engineers, working with a subcontractor, completed the final design of the HIHTL and submitted the final design package to the Department of Energy (DOE) for approval. Four booster pump stations will provide the motive force for transferring sludge slurry from K-East to K-West Basin. The design includes five 500-foot sections of hose, each consisting of two hose lengths connected by a swaged steel connector.

The leak detection system for the HIHTL consists of conductivity probes placed in the sump of each booster pump station and at the entrance/exit point of each basin. The entrance point into each booster pump station is 2 to 3 feet above the ground, where the transfer line lies. For a leak in the inner hose to be detected, the entire annulus of a 500-foot section of the HIHTL would have to fill before the sludge slurry could spill over into the pump station. This amounts to a leak of approximately 240 gallons of sludge slurry and almost an order of magnitude increase in dose rates in the vicinity of the hose before a leak can be detected. Recent efforts to improve water quality in the basins have led to conductivity levels in the basins that challenge the lower detection limit of the leak detectors. It is not clear whether the uncertainties associated with the instrument and water testing have been adequately considered to ensure the operability of the system or whether the current conductivity represents a bounding low condition. The preliminary Documented Safety Analysis does not include controls to ensure that conductivity is within acceptable ranges prior to sludge transfers.

Abrasion testing of the HIHTL showed that the material used, ethylene propylene diene monomer, has good erosion and radiation resistance, but the pump casing used in testing failed because of erosion after only 2 hours of use. Previous experience in the K-Basins has shown that the sludge has a tendency to erode metal equipment, such as pumps. It is unclear whether the

potential for erosion of the HIHTL pumps was considered before the test pump failed. Selection and testing of the HIHTL transfer pumps have not been completed, but procurement has proceeded to accommodate long lead times. The contractor is considering installing an additional pump as a spare in each booster station as a compensatory measure. The Board's staff remains concerned about this pattern of project management, whereby initial procurement and construction precede the completion of testing and resolution of project uncertainties.

The dose rate calculation for the HIHTL accounted only for the nuclides cobalt-60 and the metastable barium-137, a daughter of cesium-137. While the barium was expected to be the primary contributor to dose, cobalt was also included because of its high-energy gamma photons. All other isotopes identified in the sludge were characterized as producing particle radiation and were not expected to contribute to overall dose rates (as particles will be completely shielded by the pump, hose walls, and water). Europium-154 has a higher activity than cobalt-60 in the sludge and also emits a strong gamma, but was not included in the dose rate calculations. FH's design reviews did not identify this erroneous design assumption in the subcontractor's dose calculations. Subcontractor analysts performed a revised dose rate calculation in response to questions raised by the Board's staff and concluded that the dose estimate should be increased by 15 percent.

Sludge Stabilization and Packaging. FH recently awarded the contract for the treatment and packaging of the K-Basin sludge to British Nuclear Fuels, Ltd. (BNFL). The project will include transfer of sludge to a nearby facility; a high-temperature, high-pressure bath for oxidation of small fuel pieces in the sludge; and subsequent grouting of all sludge in 55-gallon drums. Under this contract, BNFL will not only design, build, and test equipment, but also initially operate the system for FH. The plan is for these activities to be conducted within facilities operated by FH, and to be turned over to FH for completion of sludge processing. Coordination of the two contractors through operational readiness reviews may pose complications, and a strategy to this end has not been developed. The staff is reviewing the contract and evaluating the flowdown of requirements.

Conduct of Design and Engineering. In the early stages of the SRDP, the contractor experienced a number of deficiencies in the design, engineering, and testing of sludge retrieval equipment. These deficiencies were documented by several independent reviews and in FH's February 2004 Broader Scope Issues report, which also identified causes and corrective actions for the noted deficiencies. In the area of design, for example, the functional design criteria for the project did not establish an adequate basis for a sound design. Additionally, schedule pressure resulted in the design's progressing without complete information, necessitating design changes as needed information became available. Schedule pressure has also caused procurement and fabrication to proceed before the completion of final design and testing.

In the area of procurement, assessors had previously noted that project personnel had issued long-lead procurements prior to the completion of adequate designs and hazard analyses. This problem is mirrored by the completion of the design for the HIHTL and the start of procurement prior to the completion of erosion testing to validate design assumptions. This

testing identified design problems that had to be corrected, as well as the need for a major redesign of the pumps and pump housing. Again, procurement has preceded completion of testing of the new pump system. Moreover, as a result of the need to reevaluate pump requirements at this late stage, the pump deemed best suited for this application will not be available because of the long lead time for its procurement.

The noted deficiencies are indicative of programmatic failures in the core functions of Integrated Safety Management. Examples include the failure to properly identify the potential hazards associated with sludge-disturbing activities; to develop adequate controls for a leak during sludge transfer; and to define the scope of work, in some subprojects. DOE management has decided to conduct an independent engineering review of the HIHTL project to address these programmatic issues regarding design, engineering, and testing.

During the operational readiness review for retrieval of NLOP sludge, DOE-RL recognized that some project deficiencies persisted and directed that the contractor develop a new corrective action plan. In response, the contractor issued an SRDP Continuous Performance Improvement Plan in July 2004. According to this plan, however, extensive corrective actions were already ongoing to address engineering deficiencies, and no other specific actions would be taken. The staff found that the corrective actions called for in the February 2004 Broader Scope Issues report consisted of changes in project management, assignment of additional personnel to the project, and changes to some of the engineering procedures. Given the recent observations noted in this report and those made during previous reviews conducted last year, the staff believes that the corrective actions have not been effective, and that further attention in the areas of design, engineering, and testing is needed. FH has committed to completing a review of the effectiveness of corrective actions identified in the Broader Scope Issues report to address continuing programmatic issues. The Board's staff encouraged FH to develop a set of metrics to assist in the assessment of the engineering program and identify areas still needing improvement.