DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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May 3, 2001

The Honorable Carolyn L. Huntoon
Acting 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) recently reviewed design and construction projects now under way at the Hanford Site high-level waste tank farms. These projects are being executed by the Department of Energy's Office of River Protection to prepare the facility for delivery of high-level waste to the proposed Waste Treatment Plant for immobilization. The staff's review indicates that there needs to be a timely resolution of waste feed delivery related issues by the contractor. In particular, safety issues associated with potential flammable gas releases during waste retrieval and the need to establish an appropriate design pressure for transfer systems must be resolved early if the waste feed delivery projects are to be successful.

The enclosed report prepared by the Board's staff summarizes these issues and is provided for your use as appropriate.

Sincerely,

John T. Conway
Chairman

c: Dr. Harry Boston, Manager, DOE-ORP
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

April 5, 2001

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: S. A. Stokes

SUBJECT: Resolution of Technical Issues in Support of Waste Feed Delivery, Hanford Site

This report documents issues reviewed by the staff of the Defense Nuclear Facilities Safety Board (Board) regarding high-level waste (HLW) feed delivery projects at the Hanford Site. This review was conducted by members of the Board's staff, S. Stokes and M. Sautman.

Overview. Several projects are currently under way at the Hanford Site with the objective of providing HLW feed to the proposed Waste Treatment Plant. Two projects—Initial Tank Retrieval Systems (W-211) and Tank Farm Restoration and Safe Operations (W-314)—represent most of the ongoing activity. These projects are designed to provide the capability to retrieve and transfer waste from the double-shell tanks (DSTs) earmarked for the initial phase of treatment operations. Activities in support of waste feed delivery include development and design confirmation work, such as the conduct of mixer pump tests to validate design assumptions. These projects are summarized in the following table.

Project #	Title	Summary
W-211	Initial Tank Retrieval Systems	Provides mixer pumps, transfer pumps, and safety upgrades for retrieval of DST waste.
W-314	Tank Farm Restoration and Safe Operations	Provides transfer lines, pump pits, renovation of existing transfer capability, and safety upgrades for the transfer of HLW for treatment.

Discussion. The staff's review revealed that several long-standing technical and safety issues remain unresolved. Additionally, it is not clear that the nature and significance of these issues were understood by the cognizant personnel at the Department of Energy's Office of River Protection (DOE-ORP) prior to the staff's review. These issues are summarized below.

Flammable Gas Safety Issue—The current plan for delivery of HLW liquids to the Waste Treatment Plant involves decanting supernate from above the settled solids layer (sludge) in the tanks. Discussions with personnel from Pacific Northwest National Laboratory have indicated

that decanting operations could induce gas releases in tanks which have historically experienced episodic gas release events. Decanting reduces the hydraulic head applied to the settled solids in the tank, causing gas trapped in the solids to expand and potentially increasing the buoyancy of the solids enough to initiate a gas release event. Such gas releases could produce unacceptable concentrations of flammable gases in the tank dome space (i.e., greater than 25 percent of the lower flammability limit [LFL]). Present understanding of this phenomenon is insufficient to allow prediction of the magnitude and duration of potential gas release events, so the likelihood of exceeding 25 percent (or even 100 percent) of the LFL during decanting operations is unknown.

The control proposed by CH2MHill Hanford Group (CHG)—ceasing decanting activities upon indication of a gas release—may not be adequate to interrupt a significant gas release event sufficiently to protect against exceeding 25 percent of the LFL in the tank dome space. CHG personnel believe the risk associated with a decant-induced gas release is acceptable, based on current understanding of the mechanism for gas release events and on their evaluation of historical tank behavior. Current theory indicates that cells of gas develop in the settled solids layer and that each cell grows until it becomes buoyant and releases its gas. This theory also suggests that a number of cells are likely to be developing within a tank at any given time. CHG personnel believe that no individual cell is likely to contain enough gas to result in flammable gas concentrations greater than the LFL in the tank dome space. Additionally, based on historical tank behavior, CHG personnel believe that gas release events will take place slowly and can be controlled.

However, these conclusions are based on past gas release events that were driven by the slow accumulation of gases. A decant-induced gas release would be driven by a rapid change in hydraulic head, and could behave much differently. For example, the rapid change in hydraulic head would cause rapid gas cell maturation, and the subsequent gas release could cause a cascading effect by mixing the settled solids layer sufficiently to induce other gas cells to become buoyant. Increases in the size, rate, and duration of the release could very well result. Simply halting decanting activity would not necessarily stop this sequence of events.

In discussions with DOE-ORP personnel, it became clear that the risk of a flammable gas release during decanting was poorly understood. It is not clear why CHG's approach to controlling this hazard was accepted by DOE-ORP in the absence of a complete understanding of the technical and safety issues involved, or what role cost and schedule considerations played in the acceptance of these risks. Additionally, it was not clear why the installation of mixing pumps for controlled gas release, applied successfully in Tank 241-SY-101, was not fully evaluated by DOE-ORP. Following the staff review, DOE-ORP began an active effort to evaluate this issue. Alternative approaches, including the use of mixer pumps and the addition of raw water to prevent dramatic changes in hydraulic head are under consideration.

Design Pressure for Transfer Piping—During pipeline transfers of HLW slurries, sufficient transfer velocity is required to avoid solids settling in the transfer lines. Based on available data for the physical properties of the waste, and depending upon which data set is used, the required velocities could require transfer pressures in excess of 900 pounds per square inch (psi). This pressure is considerably greater than the design pressures for existing piping

(275 or 400 psi) and planned W-211 and W-314 piping systems. This issue had been known for some time, but DOE-ORP was unable to make progress toward its resolution until recently, when CHG identified several actions to help define a path forward: (1) maintain the 400 psi rating as each project's design value, but direct the W-211 and W-314 projects to procure, install, and test new piping to meet a minimum rating of 1,000 psi; (2) perform a structural analysis of existing Plutonium/Uranium Extraction Facility (PUREX) connectors to assess their maximum pressure rating; and (3) complete additional laboratory work to reduce the uncertainty associated with particle size. Additionally, CHG has decided to retain for future consideration the potential addition of a booster pump and further evaluation of tank-specific particle size determinations.

Although the procurement of piping rated at 1000 psi accommodates higher potential pressures within this system, other more likely failure points, e.g., valves, pumps, connections could still require replacement or re-qualification. The staff notes that performing HLW transfers under high pressure would increase the likelihood and consequences of potential leak scenarios. In addition, the staff also notes that developing well-defined functional design requirements for this safety-class system, based upon the actual materials transferred (particle size determinations), is the most direct solution to this long-standing problem.

AZ-101 Mixer Pump Studies—As part of the W-211 project, sludge mobilization studies were undertaken in Tank 241-AZ-101 during the summer of 2000. This tank contains roughly 838,000 gallons of supernate and 41,000 gallons of sludge. The primary objectives of the testing were to demonstrate the ability of two 300-horsepower mixer pumps to mobilize sludge effectively and to evaluate a variety of in-tank instruments. Though most of the testing was deemed successful, it is not apparent that the planning for this effort was sufficiently thorough. For example, it is not clear why Tank AZ-101 was selected for this testing, given its small sludge volume, and the quantity of data collected was rather limited. Careful evaluation of the data will be required to determine whether and how these results can be applied to other tanks. Future retrieval demonstrations will be needed to ensure that the various operational and safety issues under study are addressed more adequately.