DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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June 29, 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:

Members of the staff of the Defense Nuclear Facilities Safety Board (Board) recently completed a review of safety controls for the planned mobilization and removal of high-level waste from Tank 8 at the Savannah River Site's F-Area Tank Farms. This project will use slurry and transfer pumps to mobilize and transfer the waste from Tank 8 to Tank 40 as future feed for the Defense Waste Processing Facility. The primary safety concern is the potential for a hydrogen deflagration in Tank 8 due to hydrogen released from the waste during slurry pump operation.

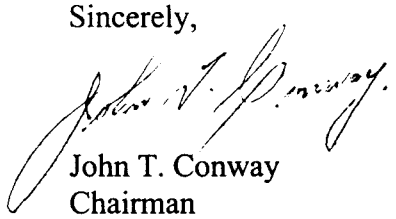
A safety evaluation performed by the contractor, Westinghouse Savannah River Company (WSRC), identified the need for safety controls because of high postulated dose consequences at the site boundary resulting from a deflagration event. The staff's review of the safety controls to be implemented by WSRC revealed several issues, including uncertainties regarding hydrogen release from the sludge during slurry pump operation and an overreliance on administrative controls, in lieu of engineered controls, to prevent a deflagration event.

Discussions between the staff and personnel from the Savannah River Site have led to a satisfactory plan for resolution of all the identified safety issues. The enclosed report summarizes the staff's observations and documents the site's commitments, and is forwarded for your information.

The Board has observed similar issues regarding the identification and implementation of safety controls in other recent reviews of activities at the Savannah River Site. For example, the Board's review of the authorization basis for the Replacement High-Level Waste Evaporator, documented in a letter transmitted to the Department of Energy on November 22, 1999, identified issues associated with the functional classification of safety-related equipment and the implementation of administrative controls. Similarly, the Board's ongoing review of the phased restart of the Savannah River Site H-Canyon has found problems in the design of safety-related alarms and interlocks relied upon to protect against various accident scenarios.

Review of the WSRC engineering manual indicates that it defines a sound program for the identification and implementation of safety-related controls for nuclear facilities. The Board believes that greater emphasis needs to be placed on the effective implementation of this design philosophy at the Savannah River Site, particularly regarding the preference for engineered controls over administrative measures and the need for a thorough understanding of the reliability and effectiveness of safety controls. The Board will continue to evaluate the implementation of this design philosophy at the Savannah River Site and throughout the defense nuclear complex, and will continue to work with the Savannah River Site to foster the effective implementation of this approach.

Sincerely,



John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.
Mr. Greg Rudy

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

April 20, 2000

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: L. M. Zull

SUBJECT: Review of Safety Controls for Tank 8 Waste Mobilization at Savannah River Site

This report documents a review of the safety controls for the planned mobilization and removal of high-level waste from Tank 8 at the Savannah River Site's (SRS) F-Area Tank Farms. The review, which included a site visit on March 8–9, 2000, and further discussions in March and April 2000, was conducted by members of the staff of the Defense Nuclear Facilities Safety Board (Board) R. T. Davis, D. K. Ralston, and L. M. Zull.

Background. Tank 8 is a single-shell high-level waste tank constructed in 1953 as one of the site's original 12 waste receipt tanks. Tank 8 received various process wastes between 1956 and 1980. In 1985 the supernate layer above the sludge was allowed to evaporate, exposing the sludge to the tank atmosphere. The waste dried, and the sludge depth receded from 87 inches to about 49 inches. In October 1998, water was added to the tank to rehydrate the sludge in preparation for its removal.

Westinghouse Savannah River Company (WSRC) has developed a plan for mobilizing the sludge with four variable-speed slurry pumps and transferring the slurry to double-shell Tank 40 in the H-Area Tank Farm. Mobilization of the sludge is expected to take about 5 months. WSRC intends that the combined waste in Tank 40 will make up the second sludge batch for feed to the Defense Waste Processing Facility (DWPF) beginning in 2001.

Potential for Hydrogen Deflagration. The primary safety concern for Tank 8 operations is the potential for hydrogen deflagration due to the release of trapped hydrogen gas during operation of the slurry pump. After a 1997 positive Unreviewed Safety Question Determination regarding the potential for hydrogen deflagration in SRS high-level waste tanks, a Justification for Continued Operation was implemented to prevent operation of the slurry pump without further analysis and appropriate controls. Accordingly, WSRC performed a safety evaluation for Tank 8 to identify appropriate controls for slurry pump operations. The safety evaluation identified the need for safety-class and safety-significant controls that would prevent deflagration during slurry pump operation because of high postulated dose consequences at the site boundary. However, rather than relying on qualified safety equipment, WSRC initially planned to rely on an operating plan and administrative controls (operator actions) using non-safety-class equipment.

The Board's staff identified several safety issues regarding WSRC's implementation of controls: (1) the procedures for mobilizing the sludge may not be sufficient to prevent a hydrogen deflagration event, (2) the equipment for pump speed control and indication is not qualified safety equipment, and (3) operator actions are relied upon exclusively to avoid a deflagration event. After numerous discussions with the Board's staff, SRS personnel proposed changes that will satisfactorily address these issues, as discussed below.

Hydrogen Retention and Release. The first issue identified by the staff is that the procedures for mobilizing the sludge may not be sufficient to prevent a hydrogen deflagration event. Previously, WSRC developed an operating plan and a procedure-based program to limit the amount of hydrogen released during slurry pump operation. The program is credited as a safety-class administrative program by WSRC. Under this program, the slurry pumps will be inserted incrementally into the sludge and gradually run up to full speed to release hydrogen from the affected volume of waste before proceeding to the next depth. The program also specifies the performance of periodic slurry pump operations after the pumps have been fully inserted, to prevent hazardous quantities of hydrogen from again accumulating in the sludge.

WSRC has performed calculations indicating that this program will prevent the hydrogen concentration in the tank headspace from exceeding 20 percent of the lower flammability limit (LFL) during slurry pump operations. The operator response to a deviation from the administrative program is to stop the slurry pumps. However, the calculations of hydrogen retention and rate of release are based on data from other waste tanks, not data on Tank 8 waste. The effects of dehydration and rewetting on the physical properties of the sludge, including the amount of hydrogen retention and the rate of hydrogen release during the planned slurry operations, are unknown. WSRC had previously intended to sample Tank 8 before waste mobilization began, but reversed that plan because of concerns related to worker exposure.

WSRC has committed to take several actions to address this issue. A special procedure will be used to verify initial conditions of tank liquid level and slurry pump height before operation of the slurry pumps begins, to better ensure that pump operations comply with the approved safety envelope. Additionally, data from a gas chromatograph will be used to verify that the quantity of hydrogen released during initial pump operations is consistent with the assumptions of the safety evaluation. This evaluation will be performed after each of the first two pumps has been operated at the initial height (50 inches) and repeated as the pumps are incrementally lowered further into the sludge. These actions to monitor the actual hydrogen released during operation of the slurry pumps will provide additional assurance that flammable gas concentrations will not approach the flammability limit.

Slurry Pump Speed. The second issue identified by the staff is that the equipment for control and indication of pump speed is general service-equipment, not qualified safety equipment. Qualified safety equipment has a greater degree of reliability in ensuring that the true pump speed is the same as that indicated to the operator in the control room. A higher pump speed could release more hydrogen from the waste than expected, and a runaway pump event could have serious consequences.

WSRC has committed to addressing this issue by implementing a hardwired interlock on slurry pump operation from the hydrogen monitor alarm circuit. This interlock will cause all slurry pumps to trip upon receipt of a high hydrogen (5 percent LFL) alarm signal. The interlock will be independent of the programmable logic controller used for the variable-speed drive on the slurry pumps. Installation of the interlock will not compromise the existing safety-significant function of the hydrogen monitor alarm. The interlock will be installed as production support equipment. The staff will review the design, procurement, and installation of the interlock, as well as the proposed requirements to control its surveillance and maintenance, to ensure that it will adequately serve its intended purpose.

WSRC also performed several evaluations to characterize potential pump runaway events. Based on the pump design and the physical characteristics of the waste, it is very unlikely that a pump runaway could be severe enough to challenge the response time of the new interlock.

Reliance on Operator Actions. The third issue identified by the staff is that operator actions were relied on exclusively to avoid a deflagration event by stopping the slurry pumps upon a flammable gas or tank ventilation system alarm. The flammable gas and tank ventilation system alarms are both safety-significant equipment, but WSRC has not developed a technical basis for the operator response time. Preliminary estimates, prepared in response to the staff's inquiry, indicate that there may not be sufficient time for the operators to take the proper actions to avoid a hydrogen deflagration event. Furthermore, if WSRC's assumptions regarding waste behavior are nonconservative, both the primary control (pump run program) and the backup control (timely operator response to the LFL alarm) could be ineffective.

The two WSRC commitments mentioned earlier (i.e., to install a hardwired interlock to stop the slurry pumps upon detection of an elevated flammable gas concentration and to implement a special procedure for evaluating initial conditions and hydrogen gas release at each incrementally agitated depth of sludge) will satisfactorily address the issue of reliance on operator actions. In particular, the effect of uncertainties associated with operator actions and response times will be significantly reduced with installation of the slurry pump interlock. Additionally, WSRC is revising its procedures to improve the effectiveness of the operator response to alarms and deviations from the operating plan by requiring that the operator disconnect power from the pumps in addition to pushing the programmed stop button.