DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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November 22, 1999

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

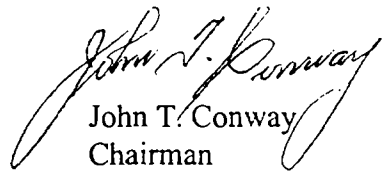
Dear Dr. Huntoon:

Members of the staff of the Defense Nuclear Facilities Safety Board (Board) recently completed a review of the safety analyses for the Replacement High-Level Waste Evaporator, which is scheduled to begin radioactive operations before the end of the year in the Savannah River Site H-Area Tank Farms. The staff's review revealed several safety issues. The main issues are related to the lack of a safety-grade system to control the evaporator level as required by the Safety Analysis Report (SAR), and the adequacy of controls to ensure timely removal of waste from a shutdown evaporator to prevent a potential hydrogen explosion. Subsequent discussions between the staff and personnel from the Savannah River Site led to a satisfactory plan for the resolution of all identified safety issues. These site commitments are documented in the enclosed report prepared by the Board's staff.

During the review, the staff also noted a recent change to site-wide guidance for the functional classification of equipment that protects the assumptions and controls the parameters used in the SAR. This change allows equipment that serves to protect assumptions regarding "initial conditions" in the accident analyses to be exempted from safety classification. The systems and components that implement SAR assumptions are major aspects of the defense-in-depth philosophy applied to the operation of defense nuclear facilities. Failure to maintain plant operations within the limits assumed in the SAR increases both the likelihood and the consequences of accidents analyzed in the SAR, and may even challenge the effectiveness of safety systems credited to prevent or mitigate those accidents. The Board believes that functional classification, surveillance, and maintenance of systems and components that protect SAR assumptions should be commensurate with the safety consequences of failing to maintain operations within the limits assumed in the SAR. The Board and its staff will monitor the application of this change in functional classification regarding "initial conditions" to other accident analyses at Savannah River Site facilities, and determine whether additional clarification or guidance is necessary.

The enclosed report provides a synopsis of the observations resulting from the staff's reviews, and is forwarded for your consideration. Please contact me if you have any questions on this matter.

Sincerely,



John T. Conway
Chairman

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

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

November 9, 1999

MEMORANDUM FOR: G. W. Cunningham, Technical Director
J. K. Fortenberry, Deputy Technical Director

COPIES: Board Members

FROM: L. M. Zull

SUBJECT: Review of Safety Analyses for Replacement High-Level Waste Evaporator at Savannah River Site

This report documents a review of the safety analyses for the new Replacement High-Level Waste Evaporator (RHLWE), which is scheduled to begin radioactive operations before the end of the year in the Savannah River Site (SRS) H-Area Tank Farms. As part of this review, site visits were conducted on April 19–22, 1999, and September 27–28, 1999, by members of the staff of the Defense Nuclear Facilities Safety Board (Board) R. T. Davis, C. H. Keilers, H. W. Massie, and L. M. Zull.

The staff's review focused on the engineered controls (systems, structures, and components [SSCs]) and administrative controls that are credited with mitigating or preventing the evaporator accidents identified in the Safety Analysis Report (SAR). The staff identified several safety issues regarding implementation of the controls identified in the SAR: (1) a safety-class system does not exist to control the evaporator level as required by the SAR, (2) removal of the waste from a shutdown evaporator is not required with adequate certainty to prevent a potential hydrogen deflagration in the tank, and (3) contractor-level administrative controls are used in cases where Technical Safety Requirement (TSR)-level controls should have been identified. Furthermore, a recent change to the SRS guidance on functional classification allows equipment that controls "initial conditions" assumed in the accident analyses to be exempted from classification as safety class or safety significant.

Discussions between the Board's staff and SRS personnel on October 7, 1999, resulted in commitments to making changes that, if implemented, will satisfactorily address the safety issues related to evaporator operation. Those issues and SRS's commitments to address them are summarized below.

Functional Classification of Evaporator Level Control. The SAR for the RHLWE identifies the need for a safety-class control for the volume of vapor space in the evaporator during two accidents: a hydrogen deflagration/explosion in the evaporator, and overpressurization due to a steam tube rupture in the evaporator. The vapor space volume depends on the waste level. To preserve the minimum vapor space volume of 875 ft^3 assumed in the SAR, the waste level must not exceed 110 inches. The level control function

can be implemented through either the level controller or a feed pump trip. A software interlock that trips the evaporator feed pump protects this initial condition; however, it does not meet the requirements for a safety-class system.

The accident scenarios for a hydrogen deflagration/explosion and an overpressurization accident depend on level to the extent that a high initial level could prevent safety controls from performing their intended function. For example, during the evaporator overpressurization accident, steam from a ruptured steam tube rapidly pressurizes the evaporator. Overpressurization of the evaporator is prevented by a safety-class system that closes the steam automatic isolation valves (AIVs) within a certain time. A higher initial level could reduce the vapor space to the point that evaporator overpressurization could occur before the AIVs could close. The ability of the safety-class AIV system to prevent the accident could therefore be compromised if the initial waste level is higher than assumed in the accident analysis.

To address this issue, Westinghouse Savannah River Company (WSRC) will revise Limiting Condition of Operation (LCO) 3.2.8 to add a surveillance requiring a daily (every shift, per procedure) comparison of the local level indicator in the evaporator building with the level indication for the Distributed Control System (DCS) in the control room. This change will be completed prior to radioactive operations. After radioactive operations begin, WSRC will evaluate the need to reperform the existing overpressurization accident analysis to reflect more realistic plant conditions. These actions provide additional assurance that the evaporator level will be maintained within the limits specified in the SAR and the TSRs, and that the effectiveness of other safety-class systems will not be compromised. These actions therefore satisfactorily address the issue of level control identified by the staff.

Hydrogen Deflagration/Explosion Controls. The SAR also identifies the potential for a hydrogen deflagration/explosion in a shutdown evaporator containing greater than residual quantities of waste. Hydrogen generated by radiolysis in the waste can accumulate in the vessel, creating the potential for an explosion. An administrative control is implemented by Process Condition for Operation (PCO) 2.16.2 to remove waste from the vessel within 10 days after shutdown, based on a calculation of the time to reach the lower flammability limit of hydrogen in air (4 percent hydrogen concentration). This calculation assumes a conservative hydrogen generation rate, but the PCO is not entered until 9 days after shutdown. The staff is concerned about the formality with which the time after steam isolation is tracked, and with the fact that waste removal actions are not required to begin sooner after shutdown.

To address this technical issue, WSRC will modify PCO 2.16.2 to add a formal daily surveillance when the evaporator is shut down to verify that steam has not been isolated for more than 2–3 days. If steam is isolated for more than 2–3 days, an action statement will require removal of waste within 10 days after steam isolation. This change will be implemented before radioactive operations begin. After the start of radioactive operations, WSRC will evaluate whether it is prudent to reperform the existing hydrogen deflagration analysis for post-shutdown conditions using more realistic source terms and plant conditions to quantify the actual margins

of safety for the postulated events. These actions provide additional assurance that hydrogen accumulation in a shutdown evaporator will not reach flammable or explosive levels, and therefore satisfactorily address this issue.

Identification of Limiting Conditions of Operation. Contractor-level controls (PCOs) are used to implement safety-related administrative controls. The Board's staff is concerned that the PCOs may not be implemented with the same rigor as TSR-level LCOs and that some evaporator PCOs should be LCOs. An example is PCO 2.16.2, discussed previously, which requires that greater-than-residual quantities of waste be removed from a shutdown evaporator within 10 days to prevent a hydrogen explosion. To address this issue, WSRC agreed to convert PCO 2.16.2 to an LCO shortly after startup. Furthermore, WSRC has committed to recommending to the Department of Energy (DOE) by February 2000 which other evaporator PCOs should be upgraded to LCOs. The staff is encouraged by the WSRC PCO/LCO upgrade activity and plans to review the results of this effort.

Change in Functional Classification for Initial Conditions. In September 1999, a change was made to Procedure 2.25, *Functional Classification*, in the *WSRC Conduct of Engineering (E7) Manual.* This change allows SSCs that serve only to protect assumptions regarding "initial conditions" in accident analyses to be exempted from classification as safety significant or safety class. WSRC cited this change to Procedure 2.25 as justification for not requiring a safety-class control for the evaporator level. The Board's staff does not believe this functional classification change is applicable to the evaporator level control since the evaporator level affects the progression of an accident and the ability of a safety-class system to perform its intended function. However, as previously discussed, the addition of a daily (every shift, per procedure) surveillance requiring a comparison of the local level indicator in the evaporator building with the DCS level indication in the control room satisfactorily addresses this issue.

With regard to the site-wide implications of the procedure change, the staff believes "initial conditions" need to be properly controlled. The safety analyses make certain assumptions and use defined parameter values as "initial conditions" to evaluate hazards. Appropriate controls for the protection of the public and workers are then identified. The systems and components that protect these assumptions are major aspects of the defense-in-depth philosophy applied to the operation of defense nuclear facilities. These systems and components need to be treated in a manner consistent with the safety consequences of failing to maintain operations within the limits assumed in the SAR. The staff intends to monitor the application of this change in functional classification for "initial conditions" to accident analyses at other SRS facilities.