DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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March 21, 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 Defense Nuclear Facilities Safety Board (Board) held a videoconference with the Department of Energy Savannah River Operations Office on February 28, 2001, regarding the americium/curium stabilization project at the Savannah River Site. The Board was informed of the progress made in improving the safety of this project and is pleased to observe that the issues raised in its letter of August 18, 2000, are being satisfactorily addressed.

The Board and its staff have reviewed the backfit and fault-tree analyses performed in support of the project's design reviews and believe that these analyses have made a significant contribution to the identification of safety enhancements. The Board notes, however, that quantitative results of the fault-tree analyses should be used with caution and mainly as a means of identifying the potential weak links in the design of control systems. The Board looks forward to the completion of these analyses and to further design improvements that may result. In particular, there appears to be an opportunity to improve the reliability of the purge system relied upon to remove explosive gases from the process vessels. The enclosed report prepared by the Board's staff is transmitted for your information and consideration as the design enhancements continue.

Sincerely,

John T. Conway
Chairman

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

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

February 26, 2001

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: F. Bamdad

SUBJECT: Americium/Curium Stabilization Project, Savannah River Site

The staff of the Defense Nuclear Facilities Safety Board (Board) held discussions with the Department of Energy (DOE) and its contractor at the Savannah River Site (SRS) on February 20–21, 2001. The focus of this review was the adequacy of hazard identification, accident analysis, and identification of controls for the americium/curium (Am/Cm) stabilization project. The review was performed at the site by staff members F. Bamdad and D. Ogg, along with Site Representatives C. Keilers and R. T. Davis.

Background. The Am/Cm stabilization project comprises two distinct processes—pretreatment and vitrification—and is to be performed in the F-Canyon facility at SRS. The Phase I pretreatment design (90 percent of the overall pretreatment design) is almost complete and is scheduled for 100 percent design review in March 2001. The vitrification process design and the Phase II pretreatment design are ongoing.

The Board transmitted a letter to DOE on August 18, 2000, summarizing issues with regard to the selection and classification of systems relied upon to perform safety-related functions for the Am/Cm project. In response to these issues, Westinghouse Savannah River Company (WSRC) performed a technical review of the safety systems credited with prevention or mitigation of the postulated accidents and proposed improvements that are being implemented by the project. These improvements include the following:

- Performance of a backfit analysis in accordance with site procedures to assess the reliability of existing systems that are required to perform a safety function (safety-class or safety-significant) for Am/Cm stabilization, but are not identified as such in the current authorization basis of the F-Canyon.

- Improvements to the Process Vessel Vent System to make it more reliable in preventing hydrogen buildup in several pretreatment tanks.

- Dedication of a head tank to be used for dilution of the 17.3E evaporator in the event of loss of cooling water flow (17.3E will store the highly concentrated Am/Cm solution for the duration of the vitrification campaign).

- An increase in the reliability of the electrical power supply to safety instrumentation by means of an uninterruptible power supply.

Additionally, the project is implementing other design features to ensure safe operations, including installation of a siphon breaker for preventing suck-back of radioactive material into unwanted areas, and blanking off some of the unused openings and manifolds to reduce the probability of unintentional transfers to outside areas.

Discussion. The Board's staff reviewed the existing design and the proposed modifications to ensure that controls will be adequate to prevent or mitigate potential accident scenarios. In general, the Am/Cm project has benefited significantly from the backfit analysis, and improvements have been identified as a result of 14 analyses performed to date. Fault-tree analyses have also been performed to quantify accident scenario frequencies for comparison with evaluation guidelines and identification of safety systems. These fault-tree analyses have been useful in the identification of weak links in the design, regardless of the calculated probability of the associated accidents. The Board's staff suggested some additional improvements to prevent certain potential accidents or reduce their likelihood. The following are examples:

Tank Headspace Purge System—The staff believes the overall reliability of tank headspace purge can and should be improved. Radiolysis of the solution in the tanks will produce hydrogen at a significant rate. Flammable concentrations of hydrogen could build up in the tank headspace within 10 to 20 minutes if the purge is lost.

WSRC believes the present design provides an adequate level of protection. This belief is based on a probabilistic analysis that indicates a rather low probability that the ignition sources exist (about $1x10^{-3}$ per year). The Board's staff believes that the uncertainties in the probabilistic analysis are significant, and that the analysis makes excessive use of theoretical values for event probabilities. It would be prudent to assume that an ignition source is available once the hydrogen concentration exceeds the lower flammability limits.

The current design provides for purging during normal operation using a safety-significant compressor that relies solely on off-site electrical power. The probability of failure for the compressor is about once per year. The backup is a single-train, safety-significant pressurized nitrogen purge system. The normal instrument air supply system is also available; however, it is not identified as a safety system even though its reliability is proven, based on past performance, to exceed that of the compressor by about an order of magnitude.

One option for improving purge reliability might be to use the instrument air supply system for purging during normal operation. The instrument air delivery system may have minor leaks, but it is supported by three relatively new air compressors and a backup diesel generator power source. Additionally, reliability of the purge system may be improved by providing a backup diesel generator for the safety-significant air compressor or, alternatively, a second nitrogen purge to back up the compressor.

Evaporator Cooling Water System—The highly concentrated solution in the 17.3E evaporator will need continuous heat removal. Inadvertent loss of cooling or failure to dilute the solution could lead to boiling and release of the radioactive material. Although the canyon exhaust system is filtered prior to release to the environment, the undesired boiling and potential

dry-out should be prevented. The current design would prevent boiling by using a manually-actuated gravity drain of about 100 liters of dilution solution into the tank upon low-level and/or high-temperature alarms. This limited amount of solution, however, is capable only of delaying the event by about 10 to 12 hours, not mitigating it completely. The identification of additional sources of dilution or cooling water is warranted to prevent boil-off (e.g., through an abnormal operating procedure). The staff believes it would be prudent to identify the necessary administrative controls and procedures as part of the safety basis of the Am/Cm project.

Protection of Safety-Related Initial Conditions. The Board's staff also evaluated whether the initial conditions assumed in the hazard and accident analyses of the Am/Cm project are adequately protected during normal operation. The Board had transmitted its concerns about WSRC practices with regard to this issue in letters to DOE dated November 22, 1999, and August 18, 2000. It appears that the Am/Cm project has judiciously identified safety-related initial conditions and intends to establish Technical Safety Requirements to ensure that they are adequately protected.