DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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June 18, 2004

The Honorable Kyle E. McSlarrow
Deputy Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Mr. McSlarrow:

In response to a letter from the Defense Nuclear Facilities Safety Board (Board) dated March 24, 2004, the Department of Energy (DOE) briefed the Board on April 27, 2004, regarding its plans for management and disposition of radioactive wastes at the Savannah River Site (SRS). The program plan outlined during the briefing is sound and incorporates many of the principles and insights imparted to DOE by the Board during the last several years, including early demonstration of decontamination technologies, minimal reliance on the unproven Low Curie Salt initiative, and elimination of recycle waste from the Defense Waste Processing Facility with an acid-side evaporator. If executed, this plan offers a high probability of successfully alleviating shortages of compliant tank space that both threaten vital site risk-reduction activities and lead to operational strategies involving increased safety risks.

Unfortunately, DOE suspended execution of this plan in early 2004 and withheld associated funding. On June 7, 2004, in light of certain legislative developments and the serious consequences of additional delays, DOE re-authorized this funding.

The Board believes that the safety impacts of delaying the radioactive waste disposition activities at SRS, as discussed in the enclosed report, are unacceptable. Given the significant safety consequences of delaying radioactive waste disposition at SRS, it is imperative that DOE execute this program in a timely manner.

Sincerely,

John T. Conway
Chairman

c: The Honorable Jessie Hill Roberson
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

May 19, 2004

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: T. D. Burns
J. S. Contardi

SUBJECT: Safety Impacts of Suspending Salt Disposition at the Savannah River Site

The status of compliant tank space in the high-level waste (HLW) tank farms at the Savannah River Site (SRS) is currently worse than when the Defense Nuclear Facilities Safety Board (Board) issued Recommendation 2001-1, *High-Level Waste Management at the Savannah River Site*, in March 2001. Although it was recognized that working space in compliant tanks would continue to decrease until salt removal capabilities had been developed and implemented, the salt disposition program was expected to proceed in a manner that would enable space gains through salt removal before compliant working space had decreased to the point of hindering vital site risk-reduction activities, such as sludge vitrification and stabilization of nuclear materials.

Recent programmatic decisions by the Department of Energy (DOE) to suspend the development of salt decontamination capabilities at SRS have called into question the ability of the salt disposition program to provide the compliant tank space necessary to execute accelerated cleanup plans for site-wide risk reduction and avoid a significant increase in the risks associated with operational activities at the tank farms. To avoid significant safety risks and major increases in the life-cycle cost of waste cleanup at SRS, the salt disposition program as currently envisioned and briefed to the Board by DOE on April 27, 2004, needs to be executed without interruption.

Background. SRS has 51 HLW tanks that store approximately 36 million gallons of waste generated from the production of defense nuclear materials. The tanks are located in two separate locations, known as the H-Area Tank Farm and the F-Area Tank Farm. There are four different types of tanks—Types I through IV. Only Type III tanks meet modern requirements for secondary containment as stipulated by the Environmental Protection Agency for leak protection. The Type I tanks are the oldest and were constructed between 1952 and 1953. The Type III tanks are the newest and entered service between 1969 and 1986. Many of the HLW tanks are already well beyond their nominal 30-year design life.

Waste Characteristics—The waste stored in the tanks includes insoluble metal hydroxide sludges and soluble salt supernate. Evaporators are used to reduce the volume of the supernate.

If concentrated enough, the soluble salts in the supernate will reach their solubility limit and precipitate out of the supernate. The precipitated salts are commonly referred to as salt cake.

The sludge component of the HLW represents approximately 3 million gallons of the total 36 million gallons stored in the tanks. However, the vast majority of the long-lived (half-life >1,000 years) radionuclides (i.e., actinides) are contained in the sludge. The sludge is currently being stabilized in the Defense Waste Processing Facility (DWPF) through vitrification for disposal in a deep geologic repository.

The major radioactive constituent in salt waste is the relatively short-lived (30-year half-life) cesium-137 nuclide, although lower levels of actinide contamination are present. Depending on the particular waste stream (e.g., canyon wastes, basin effluents), the concentration of cesium may vary. The precipitation of salts following evaporation can also change the cesium concentration. The concentration of cesium is much lower than that of the nonradioactive salts in the wastes, such as sodium nitrate and nitrite; therefore, the cesium does not reach its solubility limit and will not precipitate. As a result, the concentration of cesium in the salt cake is much lower than that in the supernate.

Historical Waste Management Operations and Planning—The failure of the In-Tank Precipitation (ITP) process for salt waste decontamination in 1998 resulted in an inability to remove and dispose of salt waste from the SRS tank farms, which in turn led to serious shortages of space in compliant Type III waste tanks. Subsequent reliability issues with the three HLW evaporators exacerbated the tank space problems to such a degree that imprudent operational strategies were considered, and in some cases implemented, to maintain the ability of the tank farms to support site activities related to vitrification and nuclear material processing. An example of these questionable operational strategies is the transfer of waste into noncompliant Type I single-shell tanks. The first tanks used in this manner, Tanks 5 and 6, leaked almost immediately.

Given the clear safety risks associated with the operational strategies implemented at SRS to deal with insufficient compliant tank space, the Board issued Recommendation 2001-1 in March 2001. In Recommendation 2001-1, the Board pointed out the reduction in safety margins arising from short-sighted operational strategies at SRS and recommended that DOE vigorously accelerate the only true solution to the tank space problem—a salt waste decontamination and disposal capability to replace the failed ITP process. DOE accepted Recommendation 2001-1 and provided an implementation plan committing to the expedited development and implementation of a salt waste decontamination and disposal capability. When DOE announced its accelerated cleanup program for reducing risks associated with legacy nuclear materials, facilities, and wastes in 2002, it was recognized that timely development and implementation of a salt waste decontamination and disposal capability was key to the program's success.

As part of its strategy, DOE planned to capitalize on the expected low concentration of cesium in the salt cake. Based on limited data, DOE decided to pursue a Low Curie Salt (LCS) initiative, in which salt cake would be drained of supernate, dissolved, processed in an existing facility to remove actinides (if needed), then disposed on site in near-surface saltstone monoliths. The LCS initiative was optimistically expected to dispose of two-thirds of all salt waste. The concentrated supernate and other salt waste containing high cesium and actinide concentrations would be processed for decontamination through a new Salt Waste Processing Facility (SWPF) prior to on-site disposal. SWPF would incorporate a new caustic-side solvent extraction technology for cesium removal and produce a decontaminated low-level waste stream that would meet Class A requirements. The cesium and actinides extracted at SWPF would be sent to DWPF for vitrification.

Revised Salt Processing Program Plan—The viability of the LCS initiative was called into question when initial salt cake characterization samples indicated that cesium and actinide concentrations exceeded the levels previously assumed. In response to this technical difficulty, the DOE's Savannah River Operations Office developed a revised salt waste disposition strategy that minimized reliance on the LCS initiative while still meeting the risk-reduction goals of the accelerated cleanup program. The revised strategy calls for the majority of the salt waste to be processed for decontamination through either SWPF or a new near-term SWPF pilot facility. To handle the increased processing requirements, the throughput capacity of SWPF was increased nearly twofold through process optimization and prudent technology selection. An acid-side evaporator was also chosen for implementation at DWPF to preserve working space in compliant Type III tanks by minimizing the volume of recycle waste returning to the tank farms.

The revised salt waste disposition strategy is sound and incorporates many of the principles and insights that the Board has imparted to DOE during the last several years, including early demonstration of decontamination technologies, minimal reliance on the unproven LCS initiative, and elimination of DWPF recycle waste with an acid-side evaporator. If executed, this revised strategy offers a high probability of successfully alleviating shortages of compliant tank space that both threaten vital risk-reduction activities at the site and lead to operational strategies involving increased safety risks. Unfortunately, DOE suspended execution of this plan in early 2004 and withheld associated funding.

Safety Impacts of Suspending Salt Disposition Activities. If not addressed, the shortage of compliant Type III tank space will increase the risks inherent in HLW processing and management. As the available tank space dwindles, it will become necessary to decide whether to continue important activities associated with sludge vitrification and stabilization of nuclear materials at the cost of employing undesirable operational strategies in the tank farms, or suspend these vital risk-reduction activities altogether. These decisions will be very difficult since delays in these risk-reduction activities could result in extended storage of liquid radioactive materials in facilities well beyond their design life, with safety controls that in many cases are less than ideal and rely heavily on compensatory measures. Some of the proposed operational strategies are similar to those that led the Board to issue Recommendation 2001-1 in March 2001. Outlined below are a few examples of undesirable operational strategies that either have been implemented or are being considered, along with the associated safety implications.

Increased Complexity of Waste Transfer—The storage of tank farm space forces more frequent and complex waste transfers. The increase in waste transfers can be readily observed from historical transfer data. Between 1987 and 1996, there were no inter-area transfers between the F and H tank farms; by contrast, the shortage of available space mean that more than nine such transfers are expected in 2005 alone. Moreover, the total volume of waste transferred in a year now far exceeds the entire waste volume stored in the tank farms. This increase in the number of transfers and the total volume transferred are the result of the lack of available tank space. For large transfers to take place, a space equal to the transfer volume must be cleared. Sometimes this requires sending waste from one tank to multiple receiving tanks. As an example, the waste in Tank 49 was removed to provide a feed tank for the LCS program. Thirteen individual transfers totaling more than 3 million gallons of waste were required to remove the waste from this one tank. The increased transfer volumes and rates increase the probability of transfer errors and leaks in facilities already beyond their expected design life.

Reduction in Contingency Tank Space—Previously, 1.3 million gallons of compliant Type III tank space was kept free in both F and H tank farms (total of 2.6 million gallons of space) to provide contingency space in the event of a leaking tank. Keeping space free in both tank farms reflected the difficulty associated with transferring waste between the F and H tank farms in a timely manner. Recently, the decision was made to reduce the contingency tank space requirement by one-half such that a total of only 1.3 million gallons of space would be held free. The allotted space is not within a single tank, but is spread among multiple tanks in both tank farms. If a tank containing a large volume of waste were to leak, the reduction in contingency space could significantly hamper emergency response operations by greatly increasing the number and complexity of the transfers needed to empty the leaking tank.

Expanded Use of Noncompliant Tanks without Secondary Containment—Eight of the 51 HLW tanks at SRS are Type IV tanks. These tanks were constructed during 1958–1962, have a single steel wall, and are beyond their design life. Two of the tanks have known cracks that may have been caused by corrosion due to groundwater. Two of the tanks have been operationally closed by being filled with grout. To create more space in the compliant Type III tanks, short-term storage of concentrated salt waste may be initiated in Type IV tanks. The concentrated salt waste contains radionuclide concentrations more than an order of magnitude greater than those of the DWPF recycle waste currently stored in the Type IV tanks. A previous attempt to expand the use of old-style tanks resulted in leakage and precipitated the issuance of the Board's Recommendation 2001-1.

Use of 3H Evaporator for DWPF Recycle Waste—As a result of vitrification operations, DWPF annually produces approximately 1.45 million gallons of recycle waste that is transferred to the tank farms. This recycle waste is segregated from canyon waste and concentrated in separate evaporators for criticality safety reasons. Specifically, when recycle waste, with high silica content, and canyon waste, with high aluminum content, are mixed and evaporated, deposits that contain significant concentrations of uranium form in the evaporator. Removal of the deposits can result in accumulation of solutions with elevated uranium concentrations in unfavorable geometries. Currently, the 2H evaporator system is used exclusively for recycle waste, and 3H is used exclusively for canyon wastes. A nonsegregated evaporator usage regime would allow more waste to be processed through the higher-capacity 3H evaporator and would serve to increase the tank space recovered by waste concentration. However, the enrichment of the uranium in the 3H system is higher than that of the uranium in the 2H system, further exacerbating the criticality risks associated with the formation of deposits. Despite the increased criticality risks, this compensatory measure will likely be pursued if the development of salt decontamination and disposal capabilities is suspended.

Redefinition of Tank 49 and 50 Process Missions—Tank 49 was previously used for storage of filtrate from the canceled ITP process. The organic waste in Tank 49 has been treated and the waste dispositioned. Tank 49 was to have been used as the feed tank for salt decontamination activities. However, Tank 49 may now be used to support sludge preparation to prevent near-term disruptions of DWPF operations. Tank 50 is the feed tank for the Saltstone Production Facility (SPF). Since SPF stabilizes only low-level waste, Tank 50 has not been used for storage of HLW. As with Tank 49, Tank 50 may be used to support sludge preparation to prevent near-term disruptions of DWPF operations. Redefining the storage missions for Tanks 49 and 50 may alleviate some near-term tank space issues but will significantly impair future salt disposition activities. SRS estimates that this strategy would delay overall cleanup of the HLW by at least 3 years and increase life-cycle costs by an estimated $1.5 billion.

Summary and Conclusions. The safety implications of exacerbating the shortage of compliant tank space at SRS by failing to proceed with the development of salt waste removal and decontamination capabilities are significant. Vital risk-reduction activities at the site, such as sludge vitrification and stabilization of nuclear materials, would be delayed, extending the time during which liquid radioactive waste will be stored in facilities well beyond their design life, with safety controls that in many cases are less than ideal and rely heavily on compensatory measures. Additionally, more aggressive operational strategies with increased safety risks would be required to manage an increasingly full HLW system.

A revised salt waste disposition strategy has been developed for SRS that addresses many of the Board's previously identified issues and incorporates many of the Board's previous insights. The revised strategy is robust and, if executed, has a high probability of successfully alleviating compliant tank space shortages that both threaten vital site risk-reduction activities and lead to operational strategies with increased safety risks. This revised salt disposition strategy should be executed without delay.