John T. Conway, Chairman
A.J. Eggenberger, Vice Chairman
Joseph J. DiNunno
John E. Mansfield

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004-2901
(202) 694-7000

July 30, 2001

The Honorable Spencer Abraham
Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Abraham:

The Defense Nuclear Facilities Safety Board (Board) has been following the development of a technology for processing of the high-level waste salt solutions and saltcake at the Savannah River Site (SRS). Implementation of this technology is crucial to solving long-term safety issues associated with tank space management at SRS, which were highlighted in the Board's Recommendation 2001-1, *High Level Waste Management at the Savannah River Site.* In addition, salt processing is required to meet regulatory commitments for waste stabilization and tank closure.

The Department of Energy (DOE) recently selected caustic side solvent extraction (CSSX) as the preferred technology for processing of salt wastes at SRS. Although the CSSX process appears promising based on initial research and development, several issues remain that could impact implementation of this technology. Notably, chemical and radiolytic degradation of the solvent and difficulties with filtration following the removal of strontium and actinides from the waste could adversely impact full-scale hot operations.

To further ensure that salt processing capabilities will be deployed successfully and safely at SRS, the Board urges DOE to pursue a back-up technology through pilot-scale operations. This strategy gives DOE more flexibility in addressing unforseen technical or programmatic issues. Small tank tetraphenylborate precipitation (STTP) appears to be an appropriate back-up technology. The DOE Savannah River Operations Office and the Westinghouse Savannah River Company have prior operations experience and have expended considerable research efforts with a chemical process (In-Tank Precipitation) that is highly similar to STTP. To date, research and development work for STTP has yielded positive results, and the remaining technical issues appear solvable.

The Board also believes it would be beneficial for DOE to continue to assess the feasibility of directly disposing of low-source-term salt wastes at SRS. The tank farms contain salt wastes of varying radionuclide content, and direct disposal of low-source-term wastes using the Saltstone Production Facility could provide a safe, timely, and cost-effective solution for achieving waste stabilization and addressing tank space issues.

The enclosed report prepared by the Board's staff addresses these matters in greater detail, and is forwarded for your information and use as appropriate.

Sincerely,

John T. Conway
Chairman

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

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

July 19, 2001

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: J. Contardi

SUBJECT: Salt Processing at Savannah River Site

This report documents issues identified by the staff of the Defense Nuclear Facilities Safety Board (Board) concerning the selection of a salt processing technology at the Savannah River Site (SRS).

Background. The Department of Energy (DOE) manages approximately 31.2 million gallons of salt solution and saltcake stored in 49 underground storage tanks at SRS. The salt wastes represent nearly 92 percent of the total volume of high-level waste (HLW) at SRS and contain 160 million curies of radioactive material. These wastes can be treated by removing key radionuclides (e.g., cesium) so that the bulk liquid can be disposed of as low-level waste. Once the salt solution has been treated, the decontaminated liquid will be sent to the SRS Saltstone Production Facility, where it will be immobilized in grout and disposed of onsite. The concentrated radionuclide stream will be mixed with sludge and vitrified at the Defense Waste Processing Facility (DWPF).

The tank farm facilities are aging, and waste retrieval and immobilization need to be accomplished before the structural integrity of the tanks is lost. A Site Treatment Plan and Federal Facilities Agreement (FFA) have established schedules and expectations for waste removal and stabilization. There are 22 tanks that do not meet U.S. Environmental Protection Agency standards for secondary containment and leak detection; these 22 noncompliant tanks are required by the FFA to be closed by 2022.

Timely implementation of a salt processing technology is a key component of the site's plans for managing tank space and meeting stabilization commitments. Further delays in deploying a salt processing capability or an unexpected reduction in usable tank space (e.g., leaking tanks or underperforming evaporator systems) could threaten safety and the ability to support site missions. The Board's Recommendation 2001-1, *High Level Waste Management at the Savannah River Site*, identified the need to address immediate issues associated with a leaking tank and the larger problem of tank space management. This recommendation also requested that DOE vigorously accelerate the schedule leading to operation of a salt processing facility.

Salt Processing Technologies. Following the cancellation of the In-Tank Precipitation (ITP) facility, DOE commissioned a study of alternative salt processing technologies. Of 140 proposed salt processing technologies, 3 were selected for further consideration: crystalline silicotitanate ion-exchange (CST), small tank tetraphenylborate precipitation (STTP), and caustic side solvent extraction (CSSX). The National Academy of Sciences (NAS) and the DOE Tanks Focus Area (TFA) have reviewed and reported on these three technologies. A fourth technology—direct disposal in the form of grout—was initially considered, but will be pursued by DOE only if the cesium removal technologies cannot be implemented.

Crystalline Silicotitanate Ion-Exchange—Research and development (R&D) activities have identified significant technical risks associated with the implementation of CST. The major areas of concern include column clogging, chemical and radiolytic degradation of the sorbent, gas generation, and issues associated with qualification of DWPF glass. Although these issues could likely be resolved with sufficient additional R&D, this processing technology has the greatest remaining risk associated with its implementation.

Small Tank Tetraphenylborate Precipitation—The precipitation chemistry used in STTP is essentially the same as that of the ITP process. However, STTP uses small, continuously agitated tanks to deal with the safety issues associated with tetraphenylborate decomposition. Some unresolved process issues remain, but engineered solutions that address these issues appear feasible. The two most notable technical risks for STTP are foaming and loss of separation efficiency due to radiolytic and chemical decomposition of tetraphenylborate.

Caustic Side Solvent Extraction—DOE's defense nuclear complex has used solvent extraction for chemical separations for more than 50 years. During the last year, significant progress has been made in the development of CSSX as a salt processing technology. Results from scale-up and flow-sheet proof-of-concept testing have been positive, but implementation issues remain. Both NAS and TFA have noted that solvent stability may represent a risk for this technology. Solvent stability has been tested with real waste, but not throughout the expected operating ranges (e.g., waste composition, pH, and temperature). NAS recommended that solvent stability testing take place in parallel with bench-scale testing using real waste. In addition, CSSX will require a separate monosodium titanate (MST) process for removal of actinides and strontium. The filtration of the MST precipitate is a slow process and may challenge facility throughput requirements. (By comparison, the STTP process performs the MST strike in conjunction with the addition of tetraphenylborate, and the resulting mixed precipitate is much easier to filter out of the waste solution.)

Path Forward. In the Final Supplemental Environmental Impact Statement, *Savannah River Site Salt Processing Alternatives* (DOE/EIS-0082-S2), DOE selected the CSSX option as the preferred salt processing alternative. CSSX appears to be an acceptable preferred option, but residual risks remain that could impact its implementation. DOE plans to demonstrate the CSSX technology in a hot pilot plant that is expected to be operational in late 2002.

A failure or delay in the CSSX project could adversely affect the HLW stabilization effort. Based on the site's planning for HLW management, salt processing will likely be the controlling factor in the completion of HLW treatment. In addition, plans for tank space management rely on start-up of salt processing by 2010; thus delays could also impact other site missions that produce waste, such as nuclear material stabilization activities or disposition of fissile materials.

The development of a back-up technology through pilot-scale operations would further ensure that the needed processing capabilities will be available when required. Of the remaining alternatives, STTP appears to be the most attractive back-up technology. The STTP technology is mature, and the site contractor has experience with a similar chemical process through the work done for ITP and treatment of the ITP washwater in Tank 49. By pursuing STTP in parallel with CSSX, DOE would have a robust strategy that would better ensure timely implementation of salt processing. The STTP pilot plant could also be used to process the ITP precipitate stored in Tank 48, thus enabling the recovery of 1.3 million gallons of tank space for HLW use. The cost for pilot-scale testing of the back-up technology would be offset by the value of the tank space made available, and could be minimized by collocating the facility with the CSSX pilot plant.

The staff also notes that SRS is evaluating the possibility of directly disposing of certain low-source-term salt wastes. The tank farms contain wastes with a wide range of radionuclide concentrations, and it may be practical and safe to directly grout salt wastes with sufficiently low cesium concentrations. If pursued in an expeditious manner, such an approach could provide a timely and cost-effective method for stabilizing waste and relieving tank space issues.