DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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March 24, 1999

The Honorable Ernest J. Moniz
Under Secretary of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585-1000

Dear Dr. Moniz:

During the past year, the staff of the Defense Nuclear Facilities Safety Board (Board) has closely followed the Department of Energy's (DOE) efforts to select a treatment technology for high-level waste liquids stored at the Savannah River Site. The DOE Savannah River Operations Office intends to select a technology by the end of September 1999, and to apply the chosen technology in a new processing facility that will replace the In-Tank Precipitation Facility. The Board's staff visited the Savannah River Site on February 9–12, 1999, to review DOE's plans for selecting a preferred alternative from the three technologies still under consideration. The conclusion of this review was that DOE's strategy was sound, but the staff developed several suggestions that have the potential to improve safety, expedite waste stabilization, and better ensure that a fair comparison is performed.

The enclosed report provides a synopsis of the observations made during the staff review and is forwarded for your consideration. If you need additional information, please do not hesitate to contact me.

Sincerely,

John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

February 26, 1999

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

COPIES: Board Members

FROM: R. Tontodonato

SUBJECT: Review of Alternatives to the In-Tank Precipitation Facility at the Savannah River Site, February 9–12, 1999

This report documents issues reviewed by the staff of the Defense Nuclear Facilities Safety Board (Board) during a visit to the Savannah River Site (SRS) by R. Tontodonato, D. Moyle, R. Robinson, and J. West on February 9–12, 1999. The principal issues reviewed were the path forward for selecting an alternative to the In-Tank Precipitation (ITP) process and benzene generation issues in the existing ITP tanks.

Alternatives to the ITP Facility. The Department of Energy Savannah River Operations Office (DOE-SR) and Westinghouse Savannah River Company (WSRC) are continuing to evaluate alternatives for treating high-level waste (HLW) liquids at SRS. The processes under evaluation remain as described in the January 11, 1999, briefing to the Board by DOE-SR: cesium removal using either small-scale tetraphenylborate (TPB) precipitation or crystalline silicotitanate (CST) ion exchange, or direct disposal in grout. Each alternative includes a monosodium titanate (MST) strike to remove actinides and strontium, followed by separation of the MST solids at some stage of the process. DOE-SR plans to choose a process (and potentially a backup technology) by September 1999. Activities under way to support making this decision include laboratory testing and theoretical analyses, evaluation of regulatory issues for the direct grouting option, development of decision criteria, and development of a waste management strategy for the interim period.

The laboratory testing is being conducted with both simulants and real waste, and is intended to better define open issues identified in the earlier phases of the evaluation of alternatives. For TPB precipitation, the tests are aimed at defining the kinetics for the TPB precipitation and the MST strike; establishing the amount of excess TPB required, as well as other parameters for the continuous precipitation process; and demonstrating the process on a small scale using simulants (spiked with catalysts known to lead to decomposition of TPB) and real wastes. For CST ion exchange, testing is concentrated on defining the CST's performance in a range of simulant chemistries and with real waste; evaluating the stability of the material, as well as its thermal and hydraulic properties; and evaluating the severity of expected hydrogen generation and the potential for foaming in certain process steps in the Defense Waste Processing Facility (DWPF). In addition, testing will be done to verify that acceptable HLW glass can be made using the recipes required for the TPB and CST processes.

Limited testing will also be performed to support the direct grouting option, but the principal issues to be addressed are regulatory in nature. Tests will be done to evaluate the MST strike for this option (the results will also apply to the MST strike for the CST option) and to better characterize the leaching rates for cesium, nitrates, and nitrites in the grout. Performance assessments will be carried out as well, including intruder scenarios. The largest issue to be addressed, however, is the need for DOE to obtain agreement from the Nuclear Regulatory Commission that the envisioned grout waste form represents "incidental waste" and does not require disposal in a geologic repository.

Based on this review, the Board's staff believes that modified approaches to several aspects of the processes may be warranted to improve safety, expedite waste stabilization, and ensure that a fair comparison is performed:

- For the small-scale TPB option, performing precipitate destruction in the new continuous-flow precipitation facility—instead of DWPF—would remove benzene hazards from DWPF, eliminate storage and transfer of TPB precipitates (and the associated benzene hazards), and significantly improve throughput by eliminating the bottleneck posed by the DWPF Salt Cell. Furthermore, this approach would eliminate the need for significant planned modifications to convert the DWPF Salt Cell to a positive-pressure inerting strategy and minimize the disruption to the currently smooth flow of DWPF operations. DOE-SR and WSRC personnel agreed that this option had numerous attractive features, but stated that it had not been pursued in part because of the desire to maximize use of existing facilities, and in part because it would increase the up-front cost of the TPB facility.

- For the direct grouting option, building more empty grout vaults up front would help address thermal issues during curing by allowing the grout pour to be rotated among more vaults. This approach would also eliminate the grout pouring rate as a rate-controlling step, and potentially allow acceleration of waste stabilization if the MST strike and waste retrieval operations support the higher pour rate. DOE-SR and WSRC personnel indicated that this alternative had not been pursued because it would increase the up-front cost of the grout facility, and because it was unclear whether the MST strike and waste retrieval operations could be accelerated sufficiently to achieve any gain in overall throughput.

- Care needs to be taken so that the MST step is sufficiently characterized to ensure that it is not optimized for one option at the expense of the others. The MST strike and subsequent filtration are designed to be performed batchwise in the grout and CST options, and on a continuous basis concurrent with TPB precipitation in the TPB option. Testing geared toward optimizing the MST strike for the TPB option will not necessarily provide the data needed to optimize the other options. Testing will need to address batch MST strikes; continuous MST strikes; and continuous, concurrent MST and TPB strikes. The results of such tests should allow each process alternative to be paired with the most compatible method for performing the MST strike, and support optimization of cost and efficiency considerations for each option.

Benzene Generation in Existing ITP Tanks. Tank 49 at the existing ITP Facility contains TPB-bearing, moderately radioactive washwater from the 1983 process demonstration. In August 1998, it was discovered that benzene was being released from the wastes at an unexpectedly high rate. To put the degree of hazard into perspective, the highest flammable gas concentration was 6 percent of the lower flammability limit. However, the observed benzene generation rate violated the authorization basis limit for air-based operation of Tank 49, and as a result, the tank is now being maintained under a Justification for Continued Operation that requires nitrogen inerting of the tank's headspace. WSRC and the Savannah River Technology Center (SRTC) have conducted a characterization program for the tank during the past several months, using liquid and vapor samples and video inspection of the tank. This study revealed that a mix-up in data reporting had allowed the tank's hydroxide content to decay to levels known to cause TPB decomposition. Samples indicate that essentially all the TPB has decomposed, and the ongoing benzene generation is due to the decomposition of TPB's daughter products.

The results of the Recommendation 96-1 ITP chemistry program indicate that correcting the tank's hydroxide content would not halt the decomposition of the TPB daughter products. However, the benzene generation rate is low enough that little hazard exists at this point. WSRC and SRTC are preparing a report that will document these findings and recommend future actions. It is likely that they will recommend allowing the reaction to run its course, and eventually returning the tank to air-based ventilation.

A new concern was raised by the video inspection. Unexpected solids were found within the waste, indicating the potential for benzene accumulation or perhaps a solids fire. This issue is still being evaluated. WSRC is attempting to obtain samples of the solids to determine their composition. Potential solid compounds include not only innocuous carbonates and salt crystals, but also biphenyls and other organic compounds. In the interim, nitrogen inerting and control of potential ignition sources will be maintained to preserve the margin of safety.