DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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June 27, 2002

The Honorable Jessie Hill Roberson
Assistant Secretary for Environmental Management
U. S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Ms. Roberson:

The Defense Nuclear Facilities Safety Board (Board) has been following activities related to the disposal of high-level waste (HLW) at the Savannah River Site (SRS). Recently, the Department of Energy (DOE) provided the Board with several deliverables under its Implementation Plan for the Board's Recommendation 2001-1, *High-Level Waste Management at the Savannah River Site*. These deliverables include the HLW System Plan, the HLW Tank Farm Schedule Sensitivity Analysis, and an Implementation Plan revision outlining a new set of salt processing commitments. An informative follow-up briefing on these deliverables was also provided to the Board by SRS personnel on May 1, 2002. A subsequent review of accelerated clean-up plans at SRS performed by the Board's staff on May 20, 2002, provided additional insight on the status of current HLW-related activities and initiatives at SRS.

The Board accepts these deliverables and is encouraged by DOE's initiatives to ensure safe and timely disposition of HLW at SRS. However, the Board wishes to highlight a number of issues that warrant additional emphasis and will require continued DOE senior management attention:

- The results of the schedule sensitivity analysis indicate that acceleration of salt waste processing within the tank farms would serve to achieve several risk reduction goals, including accelerated waste disposition and tank closure, and would increase tank space to support safe and efficient tank farm operations. Given these benefits, the Board continues to urge DOE to pursue additional means of accelerating the processing of salt wastes at SRS, including the early demonstration of the baseline cesium-removal process and pursuit of a backup technology.

- The schedule sensitivity analysis and the HLW System Plan suggest that a 3-year outage at the Defense Waste Processing Facility (DWPF) beginning in 2006 may occur. The outage would occur because the anticipated funding in fiscal years 2003–2006 is not sufficient to support the retrieval and pretreatment of tank waste to feed DWPF. Given that DWPF is an indispensable element of the HLW disposal effort at SRS, it would be unwise to pursue a baseline plan that fails to fund work

directly supporting DWPF operations. The Board strongly urges DOE to take action to ensure that these waste retrieval and pretreatment operations will be adequately funded.

- DWPF recycle waste remains a continuing influent to the tank farms. The proposed accelerated cleanup plans include disposal of the DWPF recycle by using it to dissolve low-activity saltcake. If direct disposal of low-activity saltcake does not succeed, or if the DWPF recycle waste proves unsuitable for this application, the DWPF recycle stream would continue to burden the tank farms. It would be prudent for DOE to continue to pursue other means of eliminating the DWPF recycle stream such as an acid side evaporator.

- Safe operation of the Saltstone Production Facility (SPF) is essential for the success of the SRS initiatives to dispose of low-activity saltcake directly to grout. The SPF is an unshielded, contact-operated facility, and the safety impacts of the increased radiological source term associated with sending some saltcake directly to grout have not yet been thoroughly evaluated. Significant equipment modifications and procedural changes are anticipated for both normal operation and recovery from process upsets. It is imperative that DOE identify and address any shortcomings of the SPF prior to processing low-activity saltcake through this facility.

- The effects of low-activity saltcake disposal on the overall chemistry and radioisotope content of the tank farms remain uncertain. Previously, waste blending was relied upon to provide a consistent feed to the proposed Salt Waste Processing Facility (SWPF). Direct disposal of low-activity saltcake will eliminate some of the relied-upon blending material and could affect the ability of the SWPF to process all salt waste efficiently. Your staff indicated that DOE intends to pursue alternative technologies for cesium removal in parallel with the implementation of caustic-side solvent extraction at SWPF to mitigate this technical risk.

The Board is pleased to note that DOE intends to continue pursuing alternative technologies for cesium removal. As indicated in the Board's letter of March 4, 2002, the Board believes this to be a prudent course of action. The Board looks forward to reviewing DOE's plans for the development of such alternative technologies in more detail. Pursuant to 42 U.S.C. § 2286b(d), the Board requests that DOE provide a report within 60 days of receipt of this letter that summarizes DOE's plan for further development of alternative technologies for removal of cesium from salt wastes at SRS.

The enclosed report prepared by the Board's staff contains additional observations regarding plans for accelerated cleanup of HLW at SRS and is provided for your consideration.

Sincerely,

John T. Conway
Chairman

c: Mr. Jeffrey M. Allison
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

June 12, 2002

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: J. Contardi

SUBJECT: Accelerated High-Level Waste Cleanup, Savannah River Site

The staff of the Defense Nuclear Facilities Safety Board (Board) reviewed plans for accelerated cleanup of high-level waste (HLW) at the Department of Energy's (DOE) Savannah River Site (SRS). The review was conducted by J. Contardi, D. Ogg, R. Tontodonato, and site representative T. Burns during May 20–22, 2002. Representatives from DOE's Savannah River Operations Office (DOE-SR), Westinghouse Savannah River Company (WSRC), and the Savannah River Technology Center (SRTC) participated in discussions and tours with the staff.

Background. DOE-SR and WSRC have developed plans for accelerated cleanup and closure of HLW facilities at SRS. Major initiatives include increasing the efficiency of the Defense Waste Processing Facility (DWPF), optimizing processes for closure of HLW tanks, and disposing of low-activity saltcake without cesium removal. The proposed strategy could accelerate stabilization activities by 10 years, reduce the required number of DWPF canisters by 1000, and reduce life-cycle costs by nearly $8 billion. Execution of the strategy is contingent upon receiving funds up-front from the DOE's Cleanup Reform Account. Presently, it appears that SRS will not receive funding of the magnitude required to execute the accelerated cleanup plan fully.

Accelerated Stabilization of Sludge. DOE-SR is evaluating changing the frit material used for vitrifying HLW in DWPF. A new frit has been identified that melts more rapidly and could increase the throughput capability of DWPF. The new frit has been under development since 2000 and was recently tested in SRTC's mini-melter. The results of the testing have been favorable, and WSRC expects to incorporate the new frit into DWPF operations in July 2002. The resulting increased throughput could enable the production of 50 more canisters per year.

The HLW loading in each canister may also be increased. Tests recently completed in the SRTC mini-melter using the new frit material have shown that waste loading may be increased by approximately 30 percent without adversely affecting the durability of the glass. The actual increased waste loading will depend on the composition of the sludge batch. In addition, WSRC has determined that the fill height for the canister may be raised 4 inches to the 100-inch level, allowing more glass to be poured into each canister.

These changes to DWPF operations entail certain technical and programmatic risks. The new frit would decrease the viscosity of the glass and could exacerbate existing problems with melter pouring. Moreover, it is not yet clear whether the anticipated gains in waste loading and throughput can be achieved with the new frit on a production scale. Finally, in order to benefit from an increased DWPF throughput, HLW sludge must be retrieved and prepared for transfer to DWPF at a corresponding rate. Even at the present rate of DWPF production, WSRC forecasts a three-year melter outage beginning in 2006 due to the lack of pretreated sludge feed. Additional resources would need to be applied to sludge retrieval and pretreatment in order to avoid such an outage and support increased production by DWPF.

With or without the implementation of the new frit material, recycle waste from DWPF operations remains a significant influent stream to the tank farms. WSRC hopes to eliminate a substantial amount of DWPF recycle waste by using it to dissolve low-activity saltcake. If direct disposal of low-activity saltcake does not succeed, or if the DWPF recycle waste proves unsuitable for this application, the DWPF recycle stream would continue to burden the tank farms. It would be prudent for DOE to continue to pursue alternate means of eliminating the DWPF recycle stream.

HLW Tank Closure. DOE and WSRC are pursuing a performance-based approach to future tank closures, instead of removing waste down to a predetermined residual volume. The proposed approach to closure of Tank 19 illustrates this situation. Tank 19 currently contains 15,000 gallons of waste—more than 10 times the previous tank cleaning goals. However, the residual radioactivity is less than what remained in Tank 17 when it was closed. Much of the residual waste in Tank 19 is relatively benign zeolite material which had been used to adsorb cesium from HLW evaporator overheads. The zeolite has proven to be difficult to remove, and WSRC has concluded that further retrieval efforts would not have a meaningful impact on the safety of closing Tank 19. WSRC personnel noted that it is likely that there also will be instances in which the performance-based approach will drive much more extensive waste removal efforts because of the specific materials in certain tanks.

Disposal of Low-Activity Saltcake. The key to the accelerated cleanup proposal is the disposal of low-activity saltcake without cesium removal. WSRC expects that low-activity saltcake will fall into two categories: that which is low in cesium and actinides, and that which is low in cesium but contains higher levels of actinides. The former may be directly disposed of as low-level waste (LLW) through the existing Saltstone Production Facility (SPF), while the latter would require processing to remove actinides prior to disposal through SPF.

Saltcake characterization—WSRC projects that about 10 million gallons of saltcake may be disposed of as LLW, but characterization of the saltcake tanks to support this expectation has not been accomplished. It appears that WSRC intends to characterize each tank as its contents are dissolved, which may result in the belated discovery that wastes cannot be disposed of as planned. It would be prudent to characterize the candidate tanks for the low-activity saltcake disposal program as early as practical.

Actinide removal—WSRC plans to use two existing facilities for the actinide removal process. Initially, a modest throughput would be achieved using the Late Wash Facility to house a reaction tank, a cross-flow filter, and a precipitate holding tank. If this initial demonstration proves successful, WSRC plans to install two additional reaction tanks in the In-Tank Precipitation (ITP) Facility's Filter-Stripper Building to increase the throughput of the process. The filtrate would be sent to Tank 50 for transfer to SPF, and the actinide-bearing solids would be sent to DWPF. The chemical process for actinide removal has not been defined yet. WSRC personnel stated that the most likely options are adsorption using monosodium titanate or precipitation using permanganate. Monosodium titanate has been considered the baseline technology for actinide removal at SRS, but concerns remain regarding the efficiency with which the monosodium titanate powder can be filtered from the waste solution. Testing is being pursued to support selection of a process.

Saltstone Production Facility—For low-activity saltcake disposal to be successful, SPF must be capable of handling waste streams with increased cesium content. SPF is an unshielded, contact-operated facility, and the safety impacts of the increased radiological source term have not been thoroughly evaluated yet. Based on a projected waste acceptance criterion of 0.05 Ci of cesium-137 per gallon, preliminary shielding calculations indicate that dose rates at the Salt Solution Hold Tank would be 884 mr/hr at 30 cm, and dose rates at the Grout Transfer Line would be greater than 50mr/hr at 30 cm. WSRC personnel stated that they plan to add shielding to reduce dose rates to workers at SPF to acceptable levels.

Currently, the SPF relies on hands-on maintenance to recover from process upsets. Additional shielding would reduce normal operating exposures but would not be effective for recovery from major process upsets that are likely to be encountered, such as solidification of grout in various parts of the process. Recent examples of such upsets include the following:

- The contents of the grout hold tank completely solidified during recent cold runs and had to be chipped out by workers using air hammers, an approach that would be unworkable for cesium-bearing grout.

- On June 11, 2002, a plugged transfer line at SPF resulted in the spill of 100 gallons of low-level radioactive waste on the facility's roof and onto the ground. If such an upset occurred during low-activity saltcake disposal, the consequences would be much worse and cleanup would be much more hazardous and difficult.

WSRC is performing a vulnerability assessment to identify changes in operations, maintenance, and recovery procedures that would be needed to accommodate the higher-activity waste stream safely. The staff believes that significant equipment modifications and procedural changes will be needed to ensure worker protection during normal operations and recovery from process upsets.

Determination of saltcake as waste incidental to reprocessing—Since the saltcake is a product of nuclear fuel reprocessing, it is defined as HLW by law and by DOE directives. Prior to disposal as LLW, the saltcake must be determined to be waste incidental to reprocessing

(WIR). A protocol for performing the WIR analysis is defined in DOE Order 435.1, *Radioactive Waste Management.*

DOE-SR has approved the WIR analysis for the low-activity saltcake. However, the staff believes that improvements could be made to the WIR analysis to ensure it will be broadly applicable to low-activity saltcake disposal at SRS. For example, the WIR analysis makes assumptions regarding the degree to which interstitial salt solution can be drained from the saltcake, as well as the resulting radionuclide content of the drained saltcake, that may prove to be overly optimistic. Additionally, although the WIR analysis assumes that the dissolved saltcake will meet the waste acceptance criteria for SPF, it does not appear that any of the saltcake would meet the existing criteria. WSRC is developing a revised performance assessment for the saltstone vaults to support revising the SPF waste acceptance criteria to allow disposal of low-activity saltcake. The WIR analysis should reflect the results of this work.

Impact on the Salt Waste Processing Facility—DOE plans to design and construct a Salt Waste Processing Facility (SWPF) to remove cesium from salt wastes that are unsuitable for disposal as LLW. However, the research and planning supporting the chosen caustic-side solvent extraction (CSSX) technology assumed that all the salt wastes would be available to blend the feed stream to SWPF. Disposal of low-activity saltcake as LLW would change the overall chemistry of the waste remaining in the tank farms and increase the average concentration of radioisotopes in the remaining waste. The changes in radioisotope concentration and overall chemistry have yet to be quantified, but the more concentrated feed to SWPF is likely to require a higher decontamination factor and possibly reduce operational flexibility. A small-scale backup cesium removal technology could provide flexibility to deal with batches of waste that are poorly suited to CSSX.

Salt Processing. Early demonstration of a salt processing technology is essential to risk minimization. The 1–20 percent scale CSSX facility that is planned to begin operations in 2009 would not provide timely technology demonstration. Furthermore, a facility of that scale may be too large to allow the operational flexibility necessary for adequate testing. One means of providing for an early demonstration of the CSSX technology would be to include a pilot-scale facility as a part of the pending contract for the CSSX design work. Discussions with DOE-SR personnel indicated that the Request for Proposals for this effort does not preclude such an approach.

The staff believes that there remains an opportunity to provide an early demonstration of a backup technology for cesium removal using existing facilities at SRS. Although the early demonstration of an actinide removal technology is also important, using some of the available space (e.g., the filter cell in the Filter-Stripper Building) for a small-scale cesium removal demonstration would offer some important benefits. Such a facility could get an early start on salt solution processing, reducing risk in the near-term and reducing the required capacity of the SWPF. As noted earlier in this report, it could also provide the capability to handle batches of waste not well-suited for the CSSX process to be used in SWPF. Lastly, depending on the process that is used, it may provide a capability to dispose of the tetraphenylborate precipitates stored in Tank 48. The impact on the actinide removal program could be reduced or eliminated

by constructing a small facility to house the two reactor tanks that WSRC presently envisions installing in the Filter-Stripper Building. The benefits offered by a small-scale cesium removal demonstration may well offset the cost of constructing the additional tankage for actinide removal.

Americium/Curium Transfer to the Extended Sludge Processing Facility. The Board's staff reviewed plans to transfer the americium and curium solution from F-Canyon to the Extended Sludge Processing Facility for disposal as HLW. To decrease the possibility of a spurious alarm, project personnel intend to minimize nonessential alarms during the transfer evolution. The changes appear reasonable, with the exception of the plan to allow operators to spend up to an hour independently verifying area radiation monitor alarms before taking action to secure the transfer. The hour-long response time was based on a calculation showing that the dose consequences of an hour-long leak would be below the evaluation guidelines. The Board's staff disagreed with this rationale, and DOE-SR and WSRC agreed that immediate action to verify the alarm or shut down the transfer would be appropriate.