DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

July 16,2008

MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: H. Massie, E. Rozek, and R. Robinson

SUBJECT: High-Level Waste Tank Integrity Program, Savannah River Site

This report documents a review of the Savannah River Site's (SRS) High-Level Waste (HLW) Tank Integrity Program by members of the staff of the Defense Nuclear Facilities Safety Board (Board) H. Massie, R. Robinson and E. Rozek, and outside expert W. Yeniscavich. This review included an on-site visit during June 18–19,2008. The review focused on the ultrasonic testing (UT) inspection program for Type III and IIIA (double-shell) tanks and the integrity of Type IV (single-shell) tanks.

Background. This review was part of a continuing effort by the Board's staff to follow the *In-Service Inspection Plan for High-Level Waste Tanks* (Inspection Plan), which was originally provided to the Board under Recommendation 2001-1, *High-Level Waste Management at the Savannah River Site*. The Board provided comments on the original Inspection Plan in a letter dated June 11,2002, which strongly encouraged the Department of Energy (DOE) to increase the number of tanks being inspected to all 27 Type III/IIIA HLW tanks. DOE submitted Revision 1 of the Inspection Plan to the Board on April 28,2003; this revision addressed the Board's comments at that time.

The Type III/IIIA tanks are called "compliant" tanks because they have a full-height secondary enclosure to prevent any leakage of waste from the primary tank from reaching the environment. Type III/IIIA HLW tanks are the main tanks to be used for processing HLW on a long-term basis. The Type III/IIIA tanks form the foundation for meeting the objectives of the SRS HLW System Plan for safe long-term storage and processing of HLW to the year 2030. Hence, the long-term structural integrity of Type III/IIIA tanks is essential for safely achieving the SRS mission for the HLW Tank Farms.

Review of Double-Shell Type III/IIIA Tanks. Beginning in 2002, Washington Savannah River Company (WSRC) conducted UT inspections on about five tanks a year until all 27 tanks had been inspected. The staff conducted a detailed assessment of all 5 years of UT inspection data.

First-Round Inspection Results—The first round of UT inspections utilizing the P-scan technique for all 27 HLW double-shell tanks at SRS was completed in fiscal year 2007. The P-scan is a remotely operated, automated UT inspection system. It consists of a crawler attached to the steel tank by strong permanent magnetic wheels. Mounted on the crawler is a transducer that measures pitting and thinning. Approximately 0.25 to 1.0 percent of each tank wall was inspected.

No stress corrosion cracking or general corrosion was found. However, broad shallow pits ranging in depth from 0.036 to 0.065 inch were found in 5 of the 27 tanks. Since pits of this depth do not violate the reporting criterion (0.125 inch in the upper portion of the tank) or the acceptance criterion (0.250 inch in the upper portion of the tank), WSRC has referred to these types of pits as "incipient pitting." This term denotes that the pit is shallow and is not of reportable or actionable size; it does not indicate whether the pit developed recently or whether it is actively growing. WSRC does not have repeat UT data for incipient pits, so no conclusion can be reached regarding pit growth rates. However, WSRC has consistently characterized the pits as preservice flaws. The Board's staff is concerned that pitting corrosion may be service-induced and could eventually result in leaking of the double-shell tanks. Therefore, the Board's staff suggests that the new Inspection Plan require periodic reexamination of incipient pits in all 5 tanks known to have pits in order to evaluate pit growth rates.

Second-Round Inspection Plan—WSRC's Liquid Waste Organization (LWO) initially proposed conducting UT inspections of 5 of the 27 tanks within a 10-year period for the second round of tank inspections. After reevaluating the first-round data and holding discussions with the Board's staff, LWO managers are now proposing a second round of UT inspections of all 27 tanks and have added that proposal to the new Inspection Plan (Rev. 3, June 2008). The Board's staff agrees that all 27 tanks must be UT inspected, and further believes that the total surface area inspected on each tank needs to be increased.

By contrast, LWO managers have proposed inspecting an area equivalent to approximately 0.25 percent of each tank wall during the second round of UT inspections. This would include one vertical 8.5-inch-wide strip down the entire height of each tank and some small vertical and horizontal segments of welds near the bottom of each tank. Experts from LWO and Savannah River National Laboratory (SRNL) stated that the adequacy of inspecting a single vertical strip is based on the assumption that corrosion of the tanks varies only in the vertical direction and occurs uniformly around the circumference of the tank. The Board's staff disagrees with this assumption because the small vertical surface area may not provide a representative sample of the entire tank. This concern is reinforced by the variation in circumferential pitting indicated during UT of Tank 29. One of four different vertical strips of Tank 29, each 90 degrees apart around the circumference, showed signs of pitting. Therefore, it must be concluded that pitting can be localized and may be random in either the vertical or circumferential direction.

The Board's staff notes that inspecting one tank through all accessible risers would provide valuable information on the variability of corrosion around the circumference of the

tank. If corrosion were found to vary circumferentially, then inspecting vertical strips through more than one riser on each tank would be prudent for the second round of inspections.

The Board's staff also learned from WSRC personnel that Tank 49 may be more susceptible to liquid-air interface pitting at a particular height on the tank wall corresponding to a liquid level that was constant for many years. WSRC operators have recently added waste to Tank 49 as part of the salt processing campaign, but WSRC analysts plan to perform new UT inspections at the height in question. The Board's staff suggested that histories of the liquid levels of Type III/IIIA tanks be reviewed to identify tanks that have had relatively constant levels (i.e., were stagnant). These stagnant areas may have a higher potential for liquid-air interface pitting and should be included in the Inspection Plan.

Review of Single-Shell Type IV Tanks. There are eight Type IV tanks at SRS: four in F-Area and four in H-Area. These are 1.3-million-gallon tanks that consist of a single steel liner, 3/8 inch thick, encased in concrete (approximately 15 inches thick). Type IV tanks have no pan or secondary liner; any leak from these tanks has the potential to enter the soil directly. Two tanks in F-Area are known to have experienced in-leakage of groundwater, but it is not known if they experienced leakage of waste out of the tank. WSRC removed all four F-Area tanks from service; two were closed and grouted, and two are planned for closure but still contain waste that needs to be removed. The remaining four tanks in H-Area are in service and are expected to be used until at least 2012. The H-Area Type IV tanks are all above the groundwater level.

The Board's staff has been concerned about the integrity of the concrete surrounding the Type IV tanks. There are several contractor documents that point out that degradation of the concrete could lead to collapse of a tank. WSRC operators recently inspected a small area of concrete on H-Area Tank 22. The soil fill on the top outer corner of the tank was removed and the concrete examined. No indication of degradation was found, suggesting that the concrete is still intact and performing as designed. Moreover, WSRC operators conduct annual visual inspections inside of the Type IV tanks during which the concrete domes are evaluated.

The leaks in the two tanks located in F-Area were found years ago through visual inspection of the tank walls from inside the tank. Visual inspection of Type IV tanks can be conducted only in the vapor space of the tank because there is no annular space outside the tank wall and no way to see below the surface of the waste. The leaks were easily identified by the in-leakage of water. The F-Area tanks are below the groundwater level, and the leaks were attributed to external corrosion of the liner by the groundwater. H-Area tanks, which are still being used, are located above the groundwater level and were evaluated by SRNL. SRNL concluded that since the H-Area tanks are located above the groundwater level, they would not be susceptible to external corrosion of the liner by the groundwater.

WSRC personnel discussed and provided photographs of a leak site on Tank 20, a Type IV tank in F-Area that was grouted and closed in 1997. The WSRC personnel indicated that the leak site was located between two short welds on the inside surface of the tank wall. The welds

were used to hold a lifting lug during construction and potentially produced a high-stress area near the welds. The lug was subsequently cut off. The Board's staff was able to observe the leak site through close examination of photographs. Since Type IV tanks were not post-weld stress-relieved after construction, the Board's staff believes that the mechanism involved could be stress corrosion cracking in the high-stress area near the welds rather than external groundwater corrosion. The staff notes that WSRC has observed stress corrosion cracking in other tanks at SRS caused by attachment welds made during construction.

WSRC managers acknowledge the risks associated with the use of the Type IV tanks and have taken several steps to mitigate the effects of a leak should one occur. For example, WSRC has limited the curie-content of the waste accepted into the Type IV tanks. Other compensatory measures include frequently measuring the waste level in the tanks and regularly monitoring leak detection sumps around and beneath the tanks. These actions should facilitate early detection and response to a leak. Furthermore, DOE and the contractor plan to begin waste removal from the first H-Area Type IV tank as early as October 2009, with a goal of having all remaining Type IV tanks closed and grouted by 2014. The Board's staff plans to continue to monitor the performance of the Type IV tanks and review the Type IV tank inspection program. If the closure schedules for Type IV tanks are delayed, the Board's staff believes it would be prudent for WSRC to take additional compensatory measures to limit the risk presented by these tanks.

Summary of Issues. The staff identified the following issues regarding the Inspection Plan at SRS:

- The Inspection Plan is based on the assumptions that pits in the HLW tank steel liners are preexisting flaws and are not growing. These assumptions are not supported by sufficient and convincing data. As a result, the Inspection Plan should require reexamination of pits to evaluate pit growth rates in all five tanks known to have pits.

- The Inspection Plan is also based on an assumption that pitting varies only in the vertical direction along the tank walls and not in the circumferential direction. This assumption is not supported by sufficient data. The staff believes that conducting inspections in all accessible risers, spaced around the full circumference of at least one Type III/IIIA tank, would help validate assumptions in and strengthen the basis for the Inspection Plan.

- The Inspection Plan does not adequately address the potential for liquid-air interface pitting at tank heights corresponding to stagnant waste levels. UT inspection of such an area is included in the Inspection Plan for only one tank. The staff suggests conducting a review of HLW tanks having a history of relatively constant waste levels. This review could identify areas that have a high potential for pitting, which then could be included in the Inspection Plan.