DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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January 6, 2010

The Honorable Inés R. Triay
Assistant Secretary for Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Dr. Triay:

The staff of the Defense Nuclear Facilities Safety Board (Board) attended the Non-Destructive Examination Independent Review, sponsored by the Department of Energy (DOE) and held in Atlanta, Georgia, during August 25–27, 2009. One of the goals of the review was to explore faster and improved inspection techniques for high-level waste tanks. DOE is responsible for controlling general corrosion, pitting, and stress corrosion cracking of high-level waste tanks, but current technology cannot sample more than a small portion of the tank wall. Thus, the sampling data are insufficient to make confident conclusions. Various vendors presented state-of-the-art inspection techniques used to determine the condition of piping and tank walls in the chemical and pipeline industries. In addition, the liquid waste system contractor at the Savannah River Site presented the results of an expanded ultrasonic test inspection of Tank 29. Given the limitations of current inspection techniques, the Board suggests that DOE pursue new technologies for tank inspection that may prove to be more efficient and effective at reducing uncertainties associated with tank corrosion by generating more data on tank conditions.

The Board understands that researchers in the DOE complex have proposed and are developing new and more efficient techniques for inspecting the walls of high-level waste tanks. New screening techniques, such as the electromagnetic acoustic transducer inspection, may provide quick scans of a large portion of the tank wall to confirm that major flaws do not exist.

Generally, much uncertainty remains regarding tank corrosion:

- Some corrosion mechanisms are not easily predictable or well understood, particularly for pitting and crevice corrosion and at the liquid-air interface

- Some corrosion mechanisms observed in the laboratory cannot be reproduced in the high-level waste tanks and vice versa—for example, investigators have been unable to duplicate in the laboratory crevice corrosion that is observed on in-tank corrosion coupons

- It is unclear that the same chemistry controls that address stress corrosion cracking also address pitting

- The tanks are beyond their design lives and are continuing to age—improved and expanded data collection and analysis supports extension of the service lives of the high-level waste tanks

Further research and development of new techniques for tank inspections would produce valuable tools for use in DOE's tank integrity programs particularly with regard to justifying longer tank life and avoiding surprises. The enclosed staff issue report is provided for your information and use.

Sincerely,

John E. Mansfield, Ph.D.
Vice Chairman

Enclosure

c: Ms. Shirley J. Olinger
Mr. Jeffrey M. Allison
Mr. Mark B. Whitaker, Jr.

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

November 23, 2009

MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: R. Robinson

SUBJECT: Waste Tank Non-Destructive Examination Independent Review

This report documents observations resulting from the attendance of the staff of the Defense Nuclear Facilities Safety Board (Board) at the Non-Destructive Examination (NDE) Independent Review, held in Atlanta, Georgia, during August 25–27, 2009. Staff members B. Heshmatpour and R. Robinson and outside expert W. Yeniscavich attended the review. The review was initiated as a result of the May 13–15, 2008, High-Level Liquid Waste Tank Integrity Workshop, at which a task group was assigned goals to improve the NDE of high-level waste (HLW) storage tanks. Also during that workshop, preliminary results of the ultrasonic test (UT) inspection of Tank 29 were reported. The UT inspection of Tank 29 was an expanded inspection to confirm or disprove the assumption of uniform corrosion around the circumference of HLW tanks. The Board's staff held a teleconference on October 6, 2009, with Savannah River Site (SRS) personnel to discuss a number of questions related to the Tank 29 inspection.

NDE Independent Review. The review was conducted by a five-member expert panel led by Mr. Michael Terry, who is also the Corrosion Expert Panel leader and the Single-Shell Tank Expert Panel leader. The other four panel members were Dr. Bruce Thompson, NDE inspection expert; Mr. Ray Davies, risk-based inspection expert; Dr. Cary Tuckfield, statistician; and Dr. Glenn A. Washer, concrete NDE expert. The goals of the review were to:

- Identify faster inspection techniques
- Determine the appropriate amount of tank wall surface area to be inspected
- Identify improved inspection techniques for the concrete containment around tanks

Although the expert panel appeared to be qualified, some members were new to the subject of the integrity of the Department of Energy (DOE) HLW tanks. The panel addressed its goals in general terms, but made no specific NDE recommendations.

Several vendors presented various new NDE methods, including laser mapping, P-scans/underwater scans, phased-array UT, electromagnetic acoustic transducer (EMAT) testing, pit mapping, and ground-penetrating radar (for concrete inspections). The EMAT system was of particular interest because it is similar to UT but much faster (although slightly

less accurate). The Board's staff was particularly impressed by a proposal to integrate EMAT and UT systems on the same inspection device. This combination would provide the ability to inspect a considerably expanded area of the tank using the EMAT system, followed by an accurate UT scanning should anomalous indications be found on particular areas of the tank wall.

The Board's staff notes that inspection of the bottom of a HLW tank was attempted by Hanford site operators, but was unsuccessful and discontinued. The SRS contractor made no attempt to inspect the tank bottoms. The expert panel indicated it may be possible to develop a method for inspecting the tank bottoms using phased-array UT techniques. Separately, the Hanford Single-Shell Tank Expert Panel recommended another technique that could potentially be used to inspect the bottom of waste tanks. However, the SRS contractor indicated that corrosion of the bottom plates is not a problem, although no technical rationale for this conclusion was provided.

Tank 29 UT Inspection. In a letter dated September 4, 2008, the Board suggested that an inspection in all accessible risers around the full circumference of at least one Type III/IIIA tank at SRS be conducted to validate the assumption of uniform corrosion in these tanks. The SRS contractor subsequently inspected Tank 29 through 15 risers distributed around the circumference of the tank. The contractor noted that the observed pits in Tank 29 were not uniformly distributed around the tank, but based on historical information determined that the pits were pre-service pits. The inspection results also showed no pit growth for 51 pits measured in 2006 and again in 2009. As a result of this inspection, the contractor concluded that a UT inspection using an 8-inch-wide strip through one riser per tank would be sufficient in the future to verify that corrosion rates in HLW tanks do not threaten the integrity of the tanks.

Observations. The Board's staff supports the efforts of DOE to utilize expert panels and tank integrity workshops to promote a better understanding of HLW tank conditions throughout the DOE complex. These efforts help ensure consistency in the management of HLW tank integrity and bring together considerable expertise to address emerging problems.

The Board's staff believes DOE should pursue additional research and development of new techniques for inspecting HLW tanks. Current techniques are costly and slow and may not provide full assurance of tank integrity, particularly in light of the uncertainties associated with tank corrosion. The present tank wall inspections only examine a vertical strip that covers 0.25–3.0 percent of the tank's circumference—although the extensive inspection of Tank 29 at SRS revealed no significant problems, there were some nonuniformities in pitting that may or may not be explained by pre-service conditions. Generally, much uncertainty remains regarding tank corrosion:

- Some corrosion mechanisms are not easily predictable or well understood, particularly for pitting and crevice corrosion and at the liquid-air interface

- Some corrosion mechanisms observed in the laboratory cannot be reproduced in the high-level waste tanks and vice versa—for example, investigators have been unable

to duplicate in the laboratory crevice corrosion that is observed on in-tank corrosion coupons

- It is unclear that the same chemistry controls that address stress corrosion cracking also address pitting

- The tanks are beyond their design lives and are continuing to age—improved and expanded data collection and analysis supports extension of the service lives of the high-level waste tanks

The Board's staff believes much of this uncertainty can be reduced by inspecting more of the tank walls. A larger surface area could be inspected using new methods that require about the same effort as the present UT inspections. With a new screening method, such as the EMAT technique, a much larger surface can be scanned quickly to identify problem areas for closer investigation. The Board's staff believes it would be prudent for DOE to actively pursue such methods to provide greater confidence in the integrity of the HLW tanks.