DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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January 9, 1995

The Honorable Thomas P. Grumbly
Assistant Secretary for Environmental Management
Department of Energy
Washington, D.C. 20585

Dear Mr. Grumbly:

A Defense Nuclear Facilities Safety Board staff review team visited the Savannah River Site on December 12-13, 1994. This review focused on the In-Tank Precipitation (ITP) safety envelope issues raised in the Board's letter of December 12, 1994. The primary issue is the validity of the ITP safety analysis assumption that the vapor in the tank headspace is well-mixed during both normal operations and accident conditions.

The enclosed report is a synopsis of the observations made during the review and is forwarded for your consideration.

Sincerely,

John T. Conway
Chairman

c: The Honorable Tara O'Toole, EH-1
Mr. Mark Whitaker, EH-6
Dr. Mario Fiori, Manager, SR Operations Office

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

December 19, 1994

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: David C. Lowe

SUBJECT: Savannah River Site (SRS) -- In-Tank Precipitation (ITP) Safety Envelope Review Trip Report (December 12-13, 1994)

1. **Purpose:** This trip report documents the Defense Nuclear Facilities Safety Board (DNFSB) technical staff (D. Lowe, J. Roarty, R. Zavadoski, and D. Moyle) December 12-13, 1994, review of In-Tank Precipitation (ITP) safety envelope issues.

2. **Summary:** The ITP safety analysis is based on the fundamental assumption that due to inherent thermal gradients within the tank headspace, the vapor in the tank headspace is well-mixed in all situations (i.e., nitrogen purge and ventilation either operating or shutdown). This assumption is based on calculations using a one-dimensional double-diffusive natural convection model. This model was reviewed for Westinghouse Savannah River Company (WSRC) by an independent consultant. The consultant identified several uncertainties with the well-mixed assumption, and concluded that the possibility of a stratified benzene layer during normal operations should be considered. This assessment raises sufficient uncertainty with the current ITP safety envelope, such that the safety of the public and workers may not be assured.

3. **Background:** The ITP facility is used to separate high-level waste supernate into a high-level waste and a low-level waste fraction. The ITP facility is currently scheduled to commence radioactive operations in April 1995. This review was a follow-up to the November 1-4, 1994, review and focused on the issues identified in the Board's December 12, 1994, letter forwarding the trip report to the Department of Energy (DOE).

4. **Discussion:**

   a. Tank Headspace Mixing: The ITP safety analysis is based on the fundamental assumption that due to inherent thermal gradients, the tank headspace is well-mixed in all situations (i.e., nitrogen purge and ventilation either operating or shutdown). This assumption is based on calculations using a one-dimensional double-diffusive natural convection model. This model was reviewed for WSRC by an independent consultant (P. F. Peterson, Associate Professor, University of California, Berkeley) and the following is a synopsis of his comments:

1. The possibility of a stable benzene layer during normal operations should be considered.

2. The 500 standard cubic feet per minute (scfm) purge probably does not introduce significant mixing in the tanks, and the purge will have little effect on disrupting a stratified benzene layer.

3. Independent calculations show that after three days, a two meter thick layer of 30% benzene may develop on the waste surface.

This assessment raises sufficient uncertainty about the fundamental assumption in the safety analysis (i.e., well-mixed during all situations) such that a deflagration or detonation in the tank headspace cannot be deemed incredible, and the current ITP safety envelope may not be adequate to ensure the safety of the public and workers. Therefore, the DNFSB staff believes that validation of the well-mixed assumption is necessary prior to ITP Cycle 1 startup.

WSRC recently decided to develop a three-dimensional model of the tank headspace. The scope of this effort is not well-defined, but WSRC expects some results in the April 1995 timeframe. However, WSRC stated that ITP Cycle 1 startup is not dependent on this effort. In addition, WSRC committed to taking vapor samples at different tank locations and various headspace heights during the Cycle 1 Hot Functional Tests in order to obtain a three-dimensional concentration profile of the tank headspace. This will help confirm the well-mixed assumption and benchmark the computer models. However, the specifics of how the sampling program will be implemented are still under development.

b. Hot Functional Test Program: The Cycle 1 Hot Functional Test Program is focused on "process optimization," instead of verifying the key safety envelope assumptions and reducing uncertainties associated with key safety related parameters (e.g., headspace mixing, benzene generation rate). However, some additional tests associated with safety related parameters were recently added to the Hot Functional Test Program. WSRC personnel also stated that they may have to rethink their "process optimization" focus for the Hot Functional Test Program.

c. Benzene Generation: Benzene is produced by radiolysis of the tetraphenylborate compounds and is either released immediately or is trapped within the tetraphenylborate salt structure. When the sodium tetraphenylborate (NaTPB) salt is dissolved during the washing step, the trapped benzene is released over a short period of time. The amount of trapped benzene is dependent on several variables and there is a high level of uncertainty associated with these variables. The various experiments/tests being done to reduce the uncertainty of the benzene generation rates do not appear to be well-integrated. The

Savannah River Technology Center (SRTC) and Georgia Tech experiments appear integrated (i.e., same SRTC person in control), but the testing planned during the Hot Functional Test Program is not integrated into an overall program. Additionally, the Hot Functional Test Program includes only qualitative tests of benzene release, and the SRTC lead scientist indicated that additional information could be obtained from the Hot Functional Test Program that would be useful in reducing the uncertainty associated with the benzene generation rate.

d. WSRC Independent Technical Oversight: It does not appear that an independent internal WSRC technical review committee (e.g., Technical Oversight Committee) has reviewed the safety issues associated with ITP. WSRC personnel stated that the only independent technical reviews were conducted by the "Hamilton" Committee (Westinghouse corporate committee), DOE-Headquarters (EH-11 and the Technical Review Group), and the DNFSB.

5. **Future Actions:** The DNFSB staff will continue to perform follow-up reviews as required to pursue the issues raised in this trip report.