[DNFSB LETTERHEAD]

April 20, 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 (Board) staff review team visited the Savannah River Site on January 31, 1995 through February 2, 1995. This review focused on the In-Tank Precipitation (ITP) safety envelope. The primary issues that the Board and staff continue to follow include those related to 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. It appears that the Department of Energy and the Westinghouse Savannah River Company are beginning to make progress in addressing these issues. The enclosed report is a synopsis of the observations made during the review and is forwarded for your consideration The Board and staff will continue to follow these issues until they have been adequately addressed.

Sincerely,

John T. Conway
Chairman

c:
The Honorable Tara O'Toole, EH-1
Mr. Mark Whitaker, EH-9
Dr. Mario Fiori, Manager, SR Operations Office

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

March 2, 1995

MEMORANDUM FOR: G. W Cunningham, Technical Director

COPIES: Board Members

FROM: Andrew F. De La Paz
David C. Lowe

SUBJECT: Savannah River Site (SRS)--In-Tank Precipitation (ITP) Safety Envelope Review Trip Report (January 31-February 2, 1995)

1. Purpose: This trip report documents a review by the Defense Nuclear Facilities Safety Board (Board) technical staff (A. De La Paz, D. Lowe, D. Moyle, and J. Roarty) and outside expert (W. Early, Myers & Early, Ltd.) January 31-February 2, 1995, regarding In-Tank Precipitation (ITP) safety envelope issues.

2. Summary: Westinghouse Savannah River Company (WSRC) is beginning to make progress in addressing some of the safety issues related to benzene generation and tank head space mixing. An analytical modeling effort has started and a phased test program is under development with "hold points" at critical milestones. The decision process at each "hold point" will be reviewed to ensure that there is sufficient technical justification to enter the next test phase.

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 mid-1995. This review was a follow-up to issues raised during an ITP safety envelope review conducted on December 12-13, 1994. The trip report for that review was transmitted to the Department of Energy (DOE) on January 9, 1995.

4. Discussion:

   a. Benzene Issues: The WSRC Benzene Issue Resolution Program is intended to address the uncertainties associated with maintaining the Tank 48 headspace atmosphere below the composite lower flammability limit (CLFL) during normal and abnormal operating conditions. As part of this program, WSRC appears to be integrating the analytical modeling, in-plant data acquisition and analysis, process and laboratory testing, and safety basis efforts.

   WSRC has formed an independent review committee consisting of experts from the chemical industry and academia. This committee should provide an independent technical assessment of the ITP safety issues.

1. Wash Water Interlock: WSRC personnel stated that they are planning to install new CLFL monitors that have an accuracy of 7%. The wash water interlock setpoint is currently set at 35% and a more desirable setting at 25% was not established because of the large uncertainty of the previous CLFL monitors (13%). The Board staff believes that WSRC should reevaluate the interlock setpoint.

2. Oxalic Acid Addition to Tank 48: Oxalic acid is used in the ITP process. The addition of oxalic acid could result in acid hydrolysis of tetraphenylborate precipitate and the release of benzene. However, the acid neutralization reaction is favored except in excess acid conditions Therefore, benzene release should be minimized if the tank liquid is mixed during oxalic acid use. WSRC stated that they would verify that mixer pump operation is procedurally required prior to use of oxalic acid.

   WSRC personnel described the current plan for "just-in-time" delivery of sodium tetraphenylborate (NaTPB), which would not require the storage of NaTPB. However, the NaTPB and oxalic acid receipt nozzles at the truck unloading station are the same except for labeling. This situation provides the potential for an inadvertent transfer of oxalic acid to Tank 48 which could result in a large benzene release. WSRC noted that a spool piece must be installed for NaTPB addition to Tank 48 as well as the sampling of truck contents prior to transfer. These requirements will reduce the possibility of an inadvertent transfer, but a simple modification to the nozzle would further reduce the risk of an inadvertent transfer.

3. Cooling Coil Fatigue Failure: In viewing a video of the 1983 test, the activity (motion) of the cooling coils appeared to be excessive. This can introduce a fatigue failure which, if experienced with NaTPB in the tank, may result in high benzene release rates. The mechanical integrity of the cooling coil piping may require additional attention considering the range and frequency of movement.

4. Additional Safety Layer: Considerable attention is being given to the scenario wherein CLFL is reached inside Tank 48. A common approach in the chemical industry for dealing with such a case is to define an additional safety layer which, if necessary, could be quickly implemented. For example, steam could be introduced into the tank head space to inert the tank upon loss of nitrogen purge

gas. Issues such as possible introduction of a vacuum (through steam condensation) and additional water in the tank would have to be addressed. Since pressure control instrumentation and a vacuum breaker already exist on Tanks 48/49, this approach could conceivably be quickly implemented to provide an additional layer of protection.

b. Tank Headspace Mixing: The use of an analytical approach (i.e., three-dimensional (3-D) model) to confirm the existence of a well-mixed vapor space, free of local accumulation of refluxed benzene, may be difficult to show conclusively. The model will require a considerable effort to benchmark, given the supporting experimental program is limited (i.e., two axial temperature profiles and a single sampling location, at several axial locations, for benzene vapor).

The availability of a partially qualified 3-D model offers the opportunity to perform enveloping analyses to ascertain the sensitivity of vapor space mixing to adverse boundary conditions as well as to accident conditions. In particular, it is very important to determine conditions under which local stratification and benzene refluxing is possible. This type of analysis will facilitate a critical assessment of using model predictions as a basis for ITP process safety.

1. Tank 48 Head Space Temperature Differential: If there is sufficient driving force (i.e., high bulk liquid temperature coupled with a cool roof temperature), there should be convective heat transfer resulting in mixing. The requirements for bulk liquid temperature and/or head space temperature differential have not been determined, but should be a product of the modeling effort. The Board staff believes that the minimum temperature differential for Tank 48 operation should be defined and implemented through the Operational Safety Requirements (OSRs).

2. Nitrogen Purge Nozzle: The Tank 48 nitrogen purge nozzle is located about 110 degrees from the purge exhaust and is orientated such that flow is tangentially away from the purge exhaust. However, the nozzle is mounted very close to the tank roof and nearly inside the riser, such that the velocity around the nozzle may be impeded. The Board staff believes that WSRC should evaluate the nitrogen purge nozzle design and location as part of the modeling effort.

3. Tank 48 Foaming: There was a large amount of foam on the waste surface during the 1983 test. In severe circumstances, this foam could insulate the liquid surface resulting in lower heat convection

and less head space mixing. WSRC reported that a downcomer would be installed on the Tank 48 cold feed line to reduce the potential for foaming. Nevertheless, the extent of foaming should be monitored during Cycle 1 operations to ensure that excessive foaming does not occur.

c. Radioactive Operations Commissioning Test Program (ROCTP): The ROCTP is envisioned to consist of three phases with "hold points" after each phase. The program will include pre-test predictions, but not acceptance criteria. The decision process at each "hold point" will be reviewed to ensure that there is sufficient technical justification to enter the next test phase.

l. Oxygen Tracer Tests: WSRC plans to run oxygen tracer tests prior to Cycle 1 operations in order to support the assumption that the Tank 48 vapor space is well mixed. The tests will begin with the tank oxygen content at atmospheric, nitrogen purge will then be initiated, and the oxygen concentration in the exhaust stream will be measured as a function of time until steady state is reached. The test will then be continued by measuring the buildup of oxygen when the nitrogen purge is terminated. A model can be derived to predict the decay and buildup of oxygen under ideal mixing conditions. From this test, WSRC expects to be able to predict the extent of mixing based on deviations from the ideal mixing case.

There are some problems with using the oxygen tracer test to draw definitive conclusions about vapor mixing. One can postulate "mixing factors" relating to both the effective mixing volume and the effective air in-leakage. Depending on the magnitude of these factors, both positive and negative deviations from ideal mixing behavior can be expected in exhaust stream oxygen measurements. For example, a non-mixing volume resulting in a smaller effective mixing volume and an air inleakage flow near the exhaust which does not mix with the headspace could result in a response curve similar to the ideal mixing case. However, the oxygen tracer test may be able to identify the extreme cases where mixing does not occur. In addition to these limitations, definitive conclusions about vapor mixing during Cycle 1 operations cannot be made because different temperature profiles and the presence of benzene could have a significant effect on mixing.

2. Instrumentation: The instrumentation requirements for the ROCTP have not been defined, but WSRC did state that no additional instrumentation would be required for the Phase I tests. The usefulness of the oxygen tracer tests are dependent on the accuracy

of the oxygen monitors.

d. Accident Analysis: The following issues were discussed.

1. Source Term Basis: The ITP safety analysis report (SAR) addendum uses 39 curies per gallon throughout the accident analysis. This value originates from the Tank Farm SAR and represents an average tank farm salt concentration at a 10 weight percent concentration. The Process Requirements (PRs) provide the limits for feed streams to ITP and include a limit on cesium-137 activity. To receive material from tanks with a higher Cs-137 curie content will require blending and the performance of an unreviewed safety question determination. However, another significant contributor to the source term, Pu-238, has no specific PR activity limit.

2. Tank 48 Ignition Source Question: A video of the 1983 test indicates that there is movement of cooling coils and metal to metal contact in Tank 48 during slurry pump operation. WSRC personnel stated that such an ignition source was not considered in the analysis that concluded that the conditional probability of an ignition source in the tank was 0.09.

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