DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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April 12, 1995

The Honorable Victor H. Reis
Assistant Secretary for Defense Programs
Department of Energy
Washington, D.C. 20585

Dear Dr. Reis:

A Defense Nuclear Facilities Safety Board (Board) staff review team visited the Savannah River Site on February 8-10, 1995, and focused on the F-Canyon safety envelope for Phase 2 activities. These activities include dissolving, head end, first cycle solvent extraction, and the conversion of uranium solutions to oxide product. A number of technical issues are discussed in the enclosed report that should be addressed. 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

February 21, 1995

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: A. De La Paz

SUBJECT: Report on Review of F-Canyon and FB-Line Safety Envelopes and Planning for Stabilization of Irradiated Fuel and Target Materials and Uranium Solutions - Savannah River Site

1. **Purpose:** This report documents a follow-up review of the safety envelopes at the FB-Line facility and the F-Canyon Phase 2 start-up activities at the Savannah River Site (SRS). The review also included discussion of the preparations for stabilization of irradiated fuel and target materials as well as uranium solutions. These reviews were conducted by Defense Nuclear Facilities Safety Board (Board) technical staff (D. Lowe, J. Roarty, A. De La Paz, and R. Robinson) on February 8-10, 1995.

2. **Summary:** Westinghouse Savannah River Company (WSRC) is proposing that some Mark 16 and Mark 22 irradiated production reactor fuel tubes be processed through F-Canyon along with the irradiated Mark 31 targets. This would result in an acceleration of the stabilization of the fuel tubes by a year without impacting the processing schedule for the Mark 31 target material. Board Recommendation 94-1 recommended that the production reactor fuel and targets be processed into forms suitable for safe interim storage within three years (i.e., May 1997). WSRC personnel estimate that the new proposal would result in completion of processing of the targets by the end of 1996 and the fuel tubes by the end of 1998. WSRC also discussed stabilization options for the highly enriched uranium solutions currently stored outside H-Canyon. The final disposition options for all of these materials will be determined in May 1995 by the record of decision for the Interim Management of Nuclear Materials Environmental Impact Statement.

3. **Background:** The review documented in this report is a follow-up to a FB-Line and F-Canyon safety envelope review conducted on December 1-2, 1994. The safety envelope is the collection of analyses (including assumptions) and their documentation supporting the safe operation of a process under normal and postulated upset conditions. Previous F-Canyon reviews concentrated on startup of the second plutonium cycle (referred to as Phase I). The plutonium nitrate solution product from the second plutonium cycle is transferred to the FB-Line for conversion to metal. The F-Canyon review documented in this trip report concentrates on the safety of operation of the dissolvers, head end, first cycle solvent extraction (product is the feed to the second uranium and plutonium cycles), and the conversion of uranium nitrate solution

product from first cycle to UO_3 in the FA-Line (referred to as Phase II). There are currently no plans to start up the second uranium cycle.

4. Discussion/Observations:

a. F-Canyon: The following issues were discussed:

1. Hydrogen Evolution During Dissolver Operations: The calculation that provides the basis for the required purge flow rate during dissolver operation does not properly take into account the production of hydrogen during an acid deficient condition. This leads to a required purge flow rate higher than that originally calculated.

   Sodium nitrate is added to the dissolver to minimize the hydrogen generation rate and aid in the dissolution of aluminum cladding. The presence of sodium nitrate is controlled by procedure and is verified by a specific gravity measurement. If sodium nitrate is not added, the amount of hydrogen generated would be excessive. Since there is a possibility of chemical addition error, the reliance on a single specific gravity measurement to verify that the proper chemistry conditions exist requires further Board staff review.

2. Dissolver Drown Tank Operation: A method to avert a runaway reaction in the dissolver is to quench it with water. There is a single drown tank that serves both dissolvers. It is possible for the operator to inadvertently drown the wrong dissolver. WSRC stated they would review the dissolver procedure for this operation.

3. Process Vessel Agitation: The WSRC Savannah River Technology Center (SRTC) recently completed a study which concluded that process vessel agitation was insufficient to completely mix an organic layer into the aqueous phase. This information was used by WSRC Separations Engineering to conclude that taking a sample from a process vessel and analyzing it for organic content was not adequate for detecting organic material in evaporator feed streams. However, the SRTC study also included recommendations for ensuring mixing of an organic layer with the aqueous phase. The F-Canyon safety envelope requires that certain process vessels be agitated prior to material transfers in order to prevent uncontrolled, organic-nitrate reactions. The results of the SRTC report raise questions whether the current F-Canyon safety envelope is adequate. SRTC is reevaluating its results and will determine the adequacy of process vessel agitation to provide sufficient mixing to prevent uncontrolled organic-nitrate reactions.

4. Organic-Nitrate Reactions in Continuous Evaporators: In the past, the primary protection against an uncontrolled, organic-nitrate reaction (e.g., Red Oil explosion) was to prevent organics from being fed to the evaporator. This was done by taking an organic analysis (O/A) sample from the evaporator feed tank. Recently, WSRC concluded that O/A measurements in these tanks are not reliable since the organic layer is not completely mixed with the aqueous phase (see 4.a.3 above). WSRC is implementing other controls that focus on ensuring sufficient cooling capacity to prevent an uncontrolled reaction. However, preventing organic feed to the evaporator is still a good practice and O/A measurement could provide an indication of organics in the feed tank. Therefore, the Board staff believes that the practice of taking O/A measurements should be continued.

5. Process Vessel Vent Flowrate: WSRC personnel stated that a pressure instrument located at the filter inlet of the Process Vessel Vent (PVV) system is being utilized to verify that adequate air flow is present to prevent accumulation of flammable concentrations of hydrogen in process vessels. The procedure for F-Canyon safety-related systems requires a 0.01-inch (water gauge) pressure differential between the canyon and each process vessel in order to ensure sufficient purge flow to prevent the buildup of hydrogen. WSRC personnel stated that the required differential pressure was calculated to be an equivalent filter inlet pressure for the PVV system. The Board staff will review the technical basis for this approach.

6. Cooling Water Monitor System: WSRC personnel stated that installation of an automatic diversion system for the Cooling Water System is planned for July 1995. This modification includes the installation of a control system to automatically operate the cooling water diversion valves if a timer is not reset within a specified time. WSRC personnel also discussed plans to upgrade detector electronics equipment in May 1995. The Board staff noted that there has been a delay of three months for automatic diversion upgrades and one month for detector electronics upgrades since these were discussed in December 1994.

b. FA-Line: The following issues were discussed:

1. FA-Line 1EU Evaporator: The FA-Line Technical Standard was recently approved by WSRC. It includes controls for preventing uncontrolled, organic-nitrate reactions. However, the controls outlined for the 1EU evaporator are less stringent than those in place for canyon evaporators. WSRC stated that this is because of reliance on decanters to ensure that organics are not present in the feed. However, the Technical Standard does not include any controls associated with decanter operation and does not provide the technical basis for this change in strategy. There is a possibility for organics to be in the feed to the FA-Line. The measures to prevent an uncontrolled,

organic-nitrate reaction should be clearly identified in the Technical Standard. WSRC stated that they would reevaluate this issue.

2. Powder Handling Facility: A tour of the FA-Line denitrator facility revealed that the powder handling area lacked adequate worker protection from UO_3 dust. Powder handling is operated with essentially no barrier between the UO_3 and the worker (not including the use of a respirator). WSRC stated they are planning to review the facility for possible safety upgrades. The Board staff believes that WSRC should consider the use of a barrier such as a ventilated enclosure around the loading area.

c. FB-Line: The following issues were raised in the December review and their current status is as follows:

1. Propagated Fire: WSRC personnel stated that they are on schedule to complete the project to tie in the ventilation exhaust systems for the third and fourth levels of FB-Line to the sand filter. This effort is currently planned to be completed in May 1995. Once complete, this modification will significantly reduce the potential consequences from a propagated fire that consumes the third and fourth level HEPA filters.

2. Ion Exchange Column Vent Area: The FB-Line uses cation and anion ion exchange columns in various process operations. There is a history of ion exchange resin explosions. These accidents have been studied and their underlying causes are fairly well understood. A corrective action from a previous incident was that ion exchange columns should have pressure relief or venting capability. Ion exchange columns in FB-Line have an ever open vent incorporated into their design. It appears that this vent is adequate for low-energy uncontrolled reactions (e.g., gassing); however, it will not protect against a high-energy uncontrolled reaction. WSRC Separations Engineering believes that adequate preventive measures are in place and there is no need for a pressure relief capability. However, SRTC has been tasked to review this issue and prepare a position on the adequacy of the current venting capacity and the safety measures for the existing ion exchange columns.

3. Hydrogen Deflagration: WSRC personnel determined previously that 30 FB-Line process vessels will require head space purging due to the production of hydrogen from radiolysis. Twenty-one of these vessels will be purged using the vessel vent system and the remaining nine will be purged using the liquid level bubblers. WSRC personnel have identified some problems while checking out the systems. WSRC is still planning on performing a functional test of the purging procedure using the vessel vent system, as well as developing an operating procedure. WSRC personnel stated that the functional test and procedure development are FB-Line restart activities. The Board staff will continue to follow the development of these actions.