DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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October 27, 1993

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 review team visited the Savannah River Site on September 14-16, 1993. The review focused on separations chemical processing activities and plans. The enclosed report is a synopsis of the observations made during the review and is forwarded for your information.

Sincerely,

John T. Conway
Chairman

Enclosure

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

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

October 1, 1993

MEMORANDUM FOR: G.W. Cunningham, Technical Director

COPIES: Board Members

FROM: David C. Lowe

SUBJECT: Savannah River Site (SRS) - Separations Chemical Processing Review Trip Report (September 14-16, 1993)

1. **Purpose:** This trip report documents the Defense Nuclear Facilities Safety Board (DNFSB) technical staff (D. Lowe) and outside expert (Dr. J. Leary, TRU Engineering Company) September 14-16, 1993 review of SRS Separations chemical processing activities and plans.

2. **Summary:**

   a. The Westinghouse Savannah River Company (WSRC) plan for reviewing the Tomsk-7 event is still evolving. Initially, the focus appeared to be on the anticipated results of a modeling effort, but the focus shifted to using what information is currently available about the Tomsk-7 accident and evaluating the potential at SRS for similar conditions.

   b. In many cases, the current technical standard limits for flammable gas levels do not meet industry standards. In most cases, WSRC Separations Engineering personnel stated that these deficiencies had been recognized and that a technical review was initiated. WSRC also indicated that the technical standards will be revised. In the case of the A-Line denitrator off-gas, WSRC did not recognize that the technical standard flammable gas limit did not meet the industry standard.

3. **Background:** F-Canyon processes uranium targets, reactor fuel, and other materials using a solvent extraction process to recover uranium and plutonium. The uranium is processed to an oxide at the F-Canyon A-Line and the plutonium solution is transferred to the FB-Line where it is processed to metal. The F-Canyon has not operated since March 1992 when it was shut down to resolve an unreviewed safety question (USQ) regarding the structural integrity of the stack liner during a seismic event. FB-Line has not operated since January 1990 when it was shutdown after completion of a campaign. F-Canyon and FB-Line are currently scheduled to resume operations in November 1993 and December 1993, respectively.

4. Discussion:

a. Separations Chemical Processing Plans: F-Canyon vessels currently contain about 80,000 gallons of material that have been stored for several years in various stages of processing. The centrifugal contactors and second plutonium cycle mixer/settlers were flushed to avoid long-term contact with organic solutions. The first priority is to process the second plutonium cycle material for feed to FB-Line. Processing the entire 80,000 gallons is expected to take six months. Thereafter, the following materials are scheduled to be processed:

1. SRS Mk-31 Slugs: 165 MTU (most at L-Reactor basin; 3 buckets at Receiving Basin for Off-Site Fuel (RBOF)) - processing priority given because of degradation of slugs stored in L-Reactor basin.

2. Taiwan Research Reactor Fuel: 22 MTU (143 bundles at RBOF - 8 dissolving cycles) - processing priority attributed to a Department of Energy (DOE) agreement. Also, some failed fuel elements (canned) are in water storage.

3. Experimental Breeder Reactor (EBR) II Fuel/Blanket: 17 MTU (60 bundles at RBOF - 9 dissolving cycles) - one failed fuel bundle with H_2 gas generation.

4. Rocky Flats Scrub Alloy: 1.5 shipments canned at Rocky Flats and ready for shipment - processing priority attributed to recovery of material.

5. Los Alamos National Laboratory (LANL) Metal: 4 buttons of delta-phase metal - processing priority attributed to desire to make alpha-phase metal.

The DOE/WSRC plan is to complete this processing by the end of FY-95 and begin terminal cleanout (TCO) of F-Canyon by April 1996. All product plutonium would be converted to alpha phase metal in FB-Line and placed in interim storage. FB-Line TCO is scheduled to begin in 1996.

The current inventory includes a highly radioactive americium - curium solution that must be dispositioned. Various alternatives are being evaluated, including their transfer to the high-level waste system. This evaluation is scheduled for completion by April 1994.

b. Tomsk-7 Lessons-Learned: On April 6, 1993 at the Tomsk-7 plant in Russia a violent chemical explosion occurred in a first cycle feed tank. This tank contained recycled uranyl nitrate, nitric acid, plutonium nitrate, degraded solvent, and some fission products. As a result of the explosion, the tank ruptured and the cell cover blew off. A secondary explosion of the released gases caused substantial damage to the crane bay above the tank, blowing out several hundred feet of non-reinforced masonry wall and starting several small fires. The surrounding area and off-site was contaminated.

A DOE team (including WSRC members) visited the Tomsk-7 site in June 19-29, 1993 to learn more about the event and capture lessons-learned. At this time, the explosion is attributed to an organic-nitrate ("red oil") type of reaction, similar to that experienced at U.S. fuel reprocessing plants.

DOE (Defense Programs) established a team to conduct facility reviews based on the Tomsk-7 lessons-learned. The DOE team established 13 generic criteria as the basis for their reviews. Subsequently on July 19-23, 1993, the DOE team reviewed SRS Separations and made several significant preliminary findings. WSRC also reviewed the potential for such an accident at SRS, but did not conduct a comprehensive review to the 13 criteria established by DOE. The DNFSB staff anticipates that: (1) the DOE team's report will be finalized and that the findings will be resolved prior to F-Canyon restart, and (2) WSRC's reviews will, as a minimum, encompass the 13 criteria established by DOE.

Current SRS Separations safety documentation does address "red oil" type accidents in heated process vessels, but the Tomsk-7 accident was initiated by chemical heating, a situation that was not considered in the safety analyses. After much discussion of what appeared to be uncoordinated plans, the WSRC Separations Engineering Manager said that WSRC will use the following approach:

1. Monitor the LANL modeling of the Tomsk-7 accident. Based on the modeling results, WSRC will determine the risk and consequences of a similar event and compare the event to the accident analysis. The modeling effort is scheduled to have some results by September 30, but a Savannah River Technology Center (SRTC) representative associated with this effort indicated that March 1994 was a more realistic date. This is not a requirement for F-Canyon startup.

2. WSRC initiated a process hazards review (PHR) to evaluate the F-Canyon process to determine whether potential exists for $>6M$ HNO_3 additions to organic or aqueous solutions that may contain organics, and to evaluate evaporator feeds. Completion of the PHR is required prior to F-Canyon startup.

An unreviewed safety question determination (USQD) has not been conducted, but one may be required per DOE Order 5480.21, *Unreviewed Safety Questions*. WSRC stated that an USQD could not be made until after the PHR effort and the modeling results become available, because of a lack of information concerning risk and consequences. Later, WSRC stated that they would reevaluate whether to conduct an USQD prior to startup.

In addition, one location was identified, in the High Activity Waste (HAW) evaporator system, that has the potential for higher organic levels than allowed by the technical standard and Operational Safety Requirements (OSR) (i.e., >0.5 volume % organics in

evaporator feed). WSRC stated that they would include this issue in their PHR review of evaporator feeds.

c. Flammable Gas Control: The potential for flammable gas generation exists in most of the unit operations which comprise the F-Canyon and FB-Line process. ANSI/NFPA 69 (American National Standard Institute/National Fire Protection Association), *Explosion Prevention Systems*, states that flammable gas levels must be maintained below 25 percent of the Lower Flammability Limit (LFL). If automatic indication with safety interlocks is provided, then the flammable gas levels must be maintained below 60 percent of LFL. The following issues were raised:

1. Currently, the OSR states that flammable gas levels must be maintained below flammable levels, and in most cases the technical standards state that the flammable gas levels must be maintained below 90% of LFL.

2. The technical standard for A-Line continuous denitrators requires an air dilution flow rate based on maintaining a worst case condition of 83% of the LFL in the process off-gas system. The WSRC cognizant process/system engineer was not aware that this situation was not in accordance with NFPA-69. WSRC Separations Engineering stated that they would review this situation.

3. Dissolver off-gas during cladding removal and dissolution has a technical standard limit for flammable gas of 90% of LFL. WSRC personnel stated that these limits are being reviewed and will be updated in a revision to the technical standard.

4. WSRC Separations Engineering is reviewing the basis for flammable gas limits for each unit operation in the FB-Line. This effort is required prior to FB-Line startup.

The DNFSB staff will review the revised technical standards and their technical bases for each F-Canyon and FB-Line unit operation prior to startup.