97-0000817

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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February 19, 1997

Mr. Mark B. Whitaker, Jr.
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Mr. Whitaker:

Enclosed for your information and distribution are nine Defense Nuclear Facilities Safety Board staff reports. The reports have been placed in our Public Reading Room.

Sincerely,

John T. Conway
Chairman

Enclosures (9)

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

November 27, 1996

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: T. Davis

SUBJECT: Status of Americium/Curium Stabilization at the Savannah River Site

1. Purpose

This report documents observations regarding the status of americium/curium (Am/Cm) stabilization at the Savannah River Site (SRS). These observations were made by members of the Defense Nuclear Facilities Safety Board (Board) staff T. Davis and M. Merritt during a visit to SRS on November 12-14, 1996.

2. Summary

The schedule for vitrification of the Am/Cm solution at SRS has been delayed from September 1998 to December 1999 because of Westinghouse Savannah River Corporation's (WSRC) underestimation of the complexity of adapting a commercial melter and because of the failure of a test melter. Completion of the project by December 1999 is optimistic in light of the complex systems development and integration issues involved.

3. Background

Tank 17.1 in F-Canyon at SRS contains approximately 15,000 liters of solution. The main actinide constituents are 9.7 kg of ^{243}Am, 2.6 kg of ^{244}Cm, 2.2 kg of ^{240}Pu, and 10.2 kg of ^{238}U, as well as 70.9 kg of lanthanides and 114.4 kg of other elements (e.g., Fe, Al, Na, Mn, Ni) in solution. The Am/Cm have value as feedstock for production of higher-atomic-number elements.

Board Recommendation 94-1 proposed that this solution be quickly processed into a more stable form. The Department of Energy (DOE) Implementation Plan for Recommendation 94-1 committed to vitrifying the solution by September 1998. Vitrification was chosen by WSRC because it would allow the quickest stabilization while ensuring that the material would be recoverable. The Record of Decision for the *Interim Management of Nuclear Material Environmental Impact Statement* at SRS identified vitrification as the preferred alternative. The glass product (approximately 150 canisters, 2" in diameter and 12" tall) will be shipped to Oak Ridge National Laboratory for storage and recovery, as needed.

Part of WSRC's basis for choosing vitrification was that a commercial melter system was available and could be used with little modification. At the time, the major technical uncertainties were believed to involve pretreatment and off-gas systems.

4. Discussion

Melter Design. Adapting the commercial melter for this application has proven to be more difficult than anticipated. The two main problems identified by WSRC are uneven temperature distribution and glass pouring.

During testing of the second in a series of test melters, the melter failed and released glass onto the floor. The failure was caused by a bad connection to a temperature sensor. The temperature sensor used by the control system (only one sensor was used for control) was reading approximately 800°C below the actual temperature. The control system increased the heat input based on this faulty temperature reading. The local melter temperature exceeded 1900°C (the operating temperature is supposed to be about 1400°C). The root causes of this failure were inadequate control system design and poor conduct of operations. Control system improvements have since been implemented, and operator training has been increased to prevent recurrence.

Current Schedule. Because of melter development problems and the melter failure, the schedule for completion of the stabilization campaign has been delayed until December 1999. Even given this delay, the remaining schedule is very aggressive. Six activities (pretreatment system, Multi-Purpose Processing Facility cleanup, melter system, off-gas system, control/ instrumentation system, and glass formulation technology) are being pursued in parallel. Proceeding in parallel involves a certain amount of risk. However, this strategy appears to be the quickest means of vitrifying the solution. The six activities are discussed in the attachment to this report.

Safety Basis. The vitrification systems (including pretreatment) involve processing of highly radioactive material in the canyon. Potential hazards include hydrogen explosion, solution overflow, uncontrolled chemical reactions, and contamination of the tank cooling water. The current F-Canyon Basis for Interim Operation (BIO) does not authorize transfers of liquids from tank 17.1. The BIO will be revised to include Am/Cm processing. Additionally, a Safety Analysis Report (SAR) addendum and either Technical Safety Requirements (TSRs) or Operational Safety Requirements (OSRs) (depending on F-Canyon's status with regard to implementing TSRs) will be developed to support the safety basis for this activity. For pretreatment, which will begin operations first (November 1998), a Preliminary Hazard Analysis is complete. The revised BIO, SAR addendum, and TSRs (or OSRs) will be complete in July 1997.

5. Future Staff Actions

The Board staff will be reviewing the design of the pretreatment and melter systems, as well as F-Canyon modifications to support these systems. Additionally, operational readiness and readiness assessments will be reviewed.

Attachment
Description of Americium/Curium Activities

- Pretreatment System: This system will remove transition metals and concentrate the solution in tank 17.3 for feed to the melter system. The process includes formic acid denitration, oxalate precipitation, and concentration. The final solution volume will be approximately 1,000 liters. Jumpers for liquid transfer between canyon vessels are currently being designed. Operations will occur in the hot side of Sections 16 and 17 of F-Canyon. A readiness assessment is scheduled to begin in March 1998, and operations are scheduled to begin in October 1998.

- Multi-Purpose Processing Facility Cleanup: The Multi-Purpose Processing Facility is a series of hot cells in Section 18 of F-Canyon that was designed for special campaigns and processing. It consists of eight racks, each with a lead glass viewing window (the rack 8 viewing window was recently installed to support Am/Cm stabilization) and remote manipulators. Racks 6, 7, and 8 will be used for Am/Cm stabilization. The existing racks in the facility are highly contaminated and must be removed before the Am/Cm racks are installed. Cleanup design and operations have already started and are scheduled to be complete in November 1997 to support installation of vitrification racks in August 1998.

- Melter System: This system takes feed solution that was processed by the pretreatment system, combines the feed with frit, heats the glass, and pours the glass into the canisters. These operations will occur in the Multi-Purpose Processing Facility. All operations will be controlled remotely.

  The two main development problems with the melter system are temperature distribution and glass pouring. The second melter, which failed after about 8 days, was modified to increase heating in the top of the melter. However, the limited testing done with the unit indicated that temperature distribution problems still existed. The next melter (scheduled for delivery in February 1997) will use zoned power. A dual power supply will be used to supply power to upper and lower connections on the melter. It will be possible to vary power to each connection in order to adjust the temperature distribution. WSRC believes the zoned power system will help eliminate the temperature distribution problems.

  The glass pouring problems occur when the glass pour is started and stopped. Pouring is controlled by a heater and air blower around the pour tube on the bottom of the melter. When pouring is started, the glass has a tendency to coagulate and drop from the tube, as opposed to starting as a continuous pour. Smaller strands of glass follow the initial mass. These strands have bowed outward and contacted the heater. WSRC is modifying the heater and air blower and studying the effects of glass viscosity in an effort to correct this problem.

  In addition to obtaining additional test units, WSRC has requested bids for building a prototype melter. The contract includes consulting on the resolution of the melter problems. This contract will be awarded in December 1996. The completed design needs to be available for integrated qualification runs in November 1997.

- Off-Gas System: The off-gas system consists of a steam jet, film cooler, quencher/scrubber, high-efficiency mist eliminator, high-efficiency particulate air (HEPA) preheater, HEPA filter, and exhauster. The steam jet provides the differential pressure required to maintain off-gas flow. The film cooler provides the initial cooling and prevents material deposition. The quencher/scrubber condenses steam and removes particulate. Following the HEPA filtering, off-gas is released to the process vessel vent system, which is the normal ventilation system for F-Canyon processing tanks. This system does additional filtering (including flow through the F-Canyon sand filters), and the filtered gas is then released through the F-Canyon stack.

  Although WSRC indicates that the F-Canyon containment and sand filters serve safety containment functions, the off-gas system is designed to remove 99.99 percent of the curie loading of the melter off-gas. WSRC estimates that during operations, 85 Ci/hr will be processed by the melter system, of which 2.62 Ci/hr will enter the off-gas system.

- Control/Instrumentation System: The melter control system will maintain the melter temperature above the liquidous temperature for the frit and below the maximum operating temperature for the melter. The system will also control the pour heater and air blower. Interlocks will likely be provided to prevent high melter temperature and canister overfilling. The control system design is scheduled to be complete in January 1997.

- Glass Formulation: WSRC is attempting to reduce the liquidous temperature of the glass. Doing so will increase the acceptable temperature range and reduce the complexity of the melter design. The best option for the glass appears to be an aluminum borosilicate glass. It has a lower liquidous temperature than other glasses considered and an acceptable viscosity for processing. Studies are being performed to ensure that it will be acceptable for pretreatment feed stream variations. Additionally, the effects of viscosity on pouring problems are being reviewed.

  A letter from Glen T. Seaborg dated May 30, 1996, raised concerns about the long-term ability of borosilicate glass to contain the Am/Cm solutions. This letter identified concerns about the build-up of helium that could cause glass degradation. WSRC has reviewed the available information and concluded that radiation effects would not prevent the glass from adequately containing the Am/Cm solution.