

John T. Conway, Chairman  
 A.J. Eggenberger, Vice Chairman  
 John W. Crawford, Jr.  
 Joseph J. DiNunno  
 Herbert John Cecil Kouts

## DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004  
 (202) 208-6400



July 15, 1996

The Honorable Alvin L. Alm  
 Assistant Secretary for  
 Environmental Management  
 Department of Energy  
 1000 Independence Avenue, SW  
 Washington, DC 20585-1000

Dear Mr. Alm:

The Defense Nuclear Facilities Safety Board's (Board) staff has reviewed the analyses supporting an Authorization Basis for Building 771 at the Rocky Flats Environmental Technology Site (RFETS). Observations made by the Board's staff are reflected in the enclosed trip reports.

The Board believes that the action proposed by Kaiser-Hill to apply the Process Hazards Analysis methodology, similar to that presented in 29 CFR 1910, *Occupational Safety and Health Standards*, to the higher hazard activities will enhance safety of operations at RFETS. This methodology has also been implemented at the Savannah River Site and is a systematic approach to identifying the vulnerabilities from an operation or activity. Implementation of controls to prevent or mitigate such vulnerabilities, coupled with considerations of defense-in-depth, would provide a reliable process for protection of the workers. Therefore, application of this safety process may be warranted at other defense nuclear facilities.

A significant number of transuranic (TRU) waste drums are stored in plutonium buildings and waste storage facilities at RFETS. An attendant safety issue for such storage is the potential for generation of flammable gases as a result of radiolytic decomposition of the waste forms. The site had scheduled all these drums to be vented by the end of fiscal year 1995 as part of the site risk reduction program. Although more than 500 drums remain unvented, venting of the drums was discontinued last year. The Board believes that venting of TRU waste drums, especially those containing ion exchange resins or cemented sludge, warrants a priority higher than the one currently assigned by the Department of Energy.

Should you need any additional information, please do not hesitate to call me.

Sincerely,

John T. Conway  
 Chairman

c: Mr. Mark B. Whitaker, Jr.

**DEFENSE NUCLEAR FACILITIES SAFETY BOARD**

May 15, 1996

**MEMORANDUM FOR:** G.W.Cunningham**COPIES:** Board Members**FROM:** Farid Bamdad**SUBJECT:** Trip Report - Review of Safety and Authorization Basis Issues at Rocky Flats Environmental Technology Site, April 22-26, 1996

1. **Purpose:** Safety and Authorization Basis for operations in Building 771 at the Rocky Flats Environmental Technology Site (RFETS) were reviewed by the Defense Nuclear Facilities Safety Board's (Board) staff (D. Lowe, F. Bamdad, R. Tontodonato, L. Miyoshi, and R. Robinson), and site representatives (R. Warther and M. Sautman) during the week of April 22, 1996. The focus of this review was the identification of process hazards and controls needed for safe operation of the activities to be performed in this building. The Board's staff also reviewed the storage and stabilization of plutonium metal and plutonium-bearing ion exchange resins.
2. **Summary:** The key findings by the Board's staff are as follows:
  - Identification of the hazards in the Basis For Operation (BFO) document is based on a worst-case approach and not on a process safety hazards analysis. The staff believes, however, that this approach is not adequately comprehensive and there may be accident scenarios with lower consequences and insufficient controls that are not identified.
  - RFETS had planned to vent all drums containing transuranic (TRU) waste last year, but funding for venting the last 500+ drums was eliminated and will not be available until at least FY97. Since the contents of most of these drums have the same hydrogen generation and overpressurization hazards as do the residues, the Board's staff believes that venting the TRU waste drums warrants a priority that is higher than the one currently assigned.
  - Delivery of a prototype processing line to prepare and package plutonium metal and oxide in accordance with the Department of Energy (DOE) Standard DOE-STD-3013-94 has been delayed four months due to funding problems.

3. **Discussion:** Safety and Authorization Basis activities at RFETS were reviewed by the Board's staff on March 6 and 7, 1996. During these meetings the Board's staff identified several deficiencies and discussed them with representatives from DOE's Rocky Flats Field Office (RFFO) and Kaiser Hill (K-H), the Integrating Contractor. Although some improvement has been made in development of the Authorization Basis for Building 771, several areas requiring further enhancement were identified by the staff, as discussed below.
  - a. **Authorization Basis:** The Authorization Basis for Building 771 is a BFO, prepared by an Expert Closure Group (ECG). The BFO is founded on the "necessary and sufficient" approach recommended by DOE. Identification of the hazards is based on a worst-case approach and not on a process safety hazards analysis. The methodology applied by the ECG identifies a set of scenarios intended to bound the consequences and specifies controls needed to prevent or mitigate these accidents. The staff believes, however, that this approach is not comprehensive since it is not based on a process hazards analysis and there may be unidentified accident scenarios that have lower consequences and insufficient controls.

The requirements and controls are not comprehensively identified and are not contained in the BFO document. For example, the double contingency criterion and dual coverage of fissile material activities by criticality safety alarms are not identified as requirements for safe operation of activities in the building. The BFO refers to building procedures that could be changed without any safety screening. K-H and RFFO representatives seemed to agree that this is a deficiency and stated that corrective actions will be taken to identify such safety commitments in the BFO documents. Identification of the commitments and controls in the BFO is also important for implementation of the Unreviewed Safety Question (USQ) program.

K-H uses the guidance provided in DOE-STD-3009-94, *Preparation Guide for U.S. DOE Nonreactor Nuclear Safety Analysis Reports*, for identification of controls needed to protect workers. The standard states that "safety-significant systems, structures, and components (SSC) designations based on worker safety are limited to those SSCs whose failure is estimated to result in an acute worker fatality or serious injuries to workers." The staff believes that this guidance is inadequate to protect the workers.

For calculation of the doses to the public, K-H uses the release fractions specified in a DOE handbook, DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. At the request of EG&G Rocky Flats (previous contractor at RFETS), Battelle-Columbus prepared a report on recommended plutonium respirable release fractions from postulated fires at RFETS that are significantly higher than those recommended by DOE.

The Board's staff believes that application of site-specific respirable release fractions from the Battelle-Columbus report would result in a more appropriate and realistic evaluation of consequences, and should therefore be used in hazards analyses performed at RFETS.

- b. **Building 771 Precipitation Process:** Solutions in Building 771 will be stabilized by hydroxide and oxalate precipitation processes. The hydroxide precipitation process will be used for approximately 290 liters of uranium-plutonium solutions containing chlorides. The oxalate precipitation process will be used for approximately 5,000 liters of plutonium nitrate solutions. The process hazards associated with these processes have not been fully characterized. An Integrated Safety Assessment (ISA) for Building 771 was conducted for these processes, but it focused on equipment failures. The Board's staff believes that ISA should be updated to include: process upsets, operator errors (e.g., inadvertent chemical additions), and other operations-related events.

Current plans are to drain plutonium solutions from the Building 771 tanks. Further stabilization of the solutions in the tanks will be delayed until the building deactivation phase. It is considered appropriate to flush (dilute nitric acid and water) the tanks soon after they are drained in order to take full advantage of the availability of qualified operators, proven procedures, and a verified flow path. DOE will be passing up an opportunity to quickly and economically put the tanks and associated piping systems in a safe shutdown condition.

- c. **Ion Exchange Resins:** RFETS possesses 20 drums and two cans of plutonium-bearing ion exchange resin residues, and an additional 110 drums and two cans of resins that qualify as TRU waste. There are also four ion exchange columns in Building 771 that still contain ion exchange resins. The ion exchange resins are mostly anion resins, which are flammable and have the potential to spontaneously burn or explode if dried out in a nitrated condition. These resins should continue to be considered unstable; they require expedited stabilization, because none has been denitrated, their moisture content is unknown, and prolonged radiation exposure has reduced their stability. At the time of this visit, a Safe Sites of Colorado (SSOC) program to characterize these resins had not yet begun. The condition of the resins, as well as the status of efforts to characterize and stabilize them, is discussed in detail in Attachment 1.

To minimize flammable gas accumulation, all of the resin drums categorized as residues have been vented. However, only 60 of the 110 resin drums categorized as TRU have been vented. RFETS had planned to vent all drums containing TRU waste last year, but funding to vent the last 500+ drums was eliminated and will not be available until at least FY97.

Most of the material in these drums (e.g., ion exchange resins) has the same hydrogen generation and overpressurization hazards as do the residues. Given the potential for a serious accident involving these drums, the Board's staff believes that venting the TRU waste drums warrants higher priority than the one currently assigned.

- d. **Plutonium Metal Storage and Packaging:** SSOC has essentially completed its inspection program for plutonium metal items that are out of compliance with the periodic inspection requirements contained in the local plutonium storage and surveillance procedure HSP 31.11 (*Transfer and Storage of Pyrophoric Plutonium for Fire Safety*). Based on inspection results for 212 items, SSOC has identified which categories of metal need to be repackaged in the near term to avoid accumulating too much unstabilized plutonium oxide in the storage containers. All items will be weighed every two years to ensure that excessive amounts of oxide do not accumulate. As of April 23, 1996, 1044 items had been dispositioned by repackaging and/or weighing. SSOC expects to disposition all 1858 packages by the end of FY96. Additional details on the inspection program and repackaging plans are provided in Attachment 2.

Delivery of a prototype processing line to prepare and package plutonium metal and oxide in accordance with the *DOE Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE-STD-3013-94) has been delayed four months due to funding problems. The contract has been placed with the vendor (BNFL), delivery to Building 707 is not expected until January 1997, and the system is not expected to be operational until July 1997. SSOC stated that the addition of a follow-on system for Building 371, scheduled to be operational by December 1998, will provide sufficient capacity at RFETS to meet the Recommendation 94-1 Implementation Plan commitment to package all plutonium metal and oxide in accordance with DOE-STD-3013-94 by May 2002.

4. **Future Action:** In a closure meeting with representatives from RFFO, K-H, and SSOC, the Board's staff summarized its findings and identified areas requiring further enhancement. The K-H management stated that it would take action to make improvements that will ensure the safety of the operations planned for Building 771 and invited the staff to review the enhancements in a follow-up meeting tentatively scheduled for late May 1996.

## Attachment 1

### Detailed discussion of RFETS ion exchange resins

1. RFETS possesses 20 drums and two cans of plutonium-bearing ion exchange resin residues, and an additional 110 drums and two cans of resins that qualify as TRU waste. There are also four ion exchange columns in Building 771 that still contain ion exchange resins; they are mostly anion resins, but some cation resins are also in storage (in some cases, mixed in with anion resin). Both types of resins are flammable. Anion resins have the added potential to undergo spontaneous fire or explosion if dried out in a nitrated condition. Radiation exposure and contact with strong oxidizers further reduce the stability of these materials. Based on its current understanding of their condition, the Board's staff believes that the RFETS resins should continue to be considered unstable and that their stabilization should be expedited.
  - None of the resins at RFETS has been denitrated. Resins still in columns are kept wet, but the moisture content of resins in drums and cans is unknown. The resins were wet when packaged, and RFETS expects them to remain wet because of the plastic bagging used in packaging. However, dryout could be occurring, since all the resin residue drums are now vented and some drums are at least 12 years old.
  - It is believed that all of the RFETS anion resins had been eluted with 0.35 molar nitric acid before they were stored as TRU waste or residues. This process should have removed the highly concentrated acids used to load the columns with Plutonium. Some were also rinsed with water in an effort to remove some of the residual acid. The low plutonium contents of the drums in storage provide confidence that the resins did indeed go through the elution process and are, therefore, not in contact with strong oxidizers.
  - The FB-Line and HB-Line at the Savannah River Site limit the total dose to anion exchange resins in service to less than 100 megarads. SSOC estimated that the worst-case resins at RFETS have received about 1000 megarads, but stated that Los Alamos National Laboratory (LANL) studies<sup>1</sup> have shown that the types of resins stored at RFETS remain stable at temperatures up to 270°C, even after receiving a dose of 550 megarads. SSOC further stated that the LANL studies concluded that "radiation exposure has no serious consequences to the stored resins," implying that any dose is acceptable.

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<sup>1</sup>LA-11912 *The Effects of Ionizing Radiation on Reillex™ HPQ, a New Macroporous Polyvinylpyridine Resin, and on Four Conventional Polystyrene Anion Exchange Resins* and LA-12055 *The Effects of In Situ Alpha-Particle Irradiations on Six Strong-Base Anion Exchange Resins*

The Board's staff subsequently reviewed the referenced reports and found that these reports do not make this conclusion. In fact, one of the principal conclusions in LA-11912 is, "We further recommend that appropriate safe processes be developed to dissolve or decompose spent, nitrate-form resins before their disposal to eliminate the possibility of gas-producing interactions between the nitrate and organic polymers during storage."

2. SSOC plans to characterize 10 drums and one can of resin residues by the end of FY96. The sampling plan will address variables such as container type, Pu loading, age, length of time in a vented container, and whether or not the resin had been washed with water to remove residual acid before packaging. Packages will be sampled in the order SSOC intends to stabilize them. As noted below, the stabilization schedule is not risk-based.
3. SSOC intends to stabilize the resin residues by cementing them in 2 kg batches along with low level plutonium solutions in the Building 774 bottle box. SSOC plans to stabilize three drums of resin residues in FY96, and the remainder by the end of FY97. SSOC stated that it might be possible to stabilize more drums of resin in FY96, but the contractual performance measure and funding only cover three drums.

The sequence for stabilization is driven primarily by convenience--not risk. The first three drums to be stabilized have low plutonium concentrations, low bulk weight, and contain resins in bottles, which will require less handling and repackaging than will the cardboard tubes used in the remaining drums. This approach appears to be reasonable, since they are some of the oldest packages and have the highest radiation dose to the resin.

SSOC does not plan to stabilize TRU resins in the near term. This decision appears to be based on the limited amount of plutonium contained in each TRU drum. However, the Board's staff notes that the hazards presented by ion exchange resins are primarily chemical in nature, as is the case for other waste types containing fuel and oxidizers in intimate contact. Further consideration for accelerating the disposition of the TRU waste resins appears to be warranted.

## Attachment 2

### Detailed discussion of plutonium metal storage and repackaging

1. SSOC has essentially completed its inspection program for plutonium metal items that are out of compliance with the periodic inspection requirements contained in the local plutonium storage and surveillance procedure HSP 31.11 (*Transfer and Storage of Pyrophoric Plutonium for Fire Safety*). The procedure requires periodic inspection and removal of loose oxide from unencapsulated metal items to ensure excessive amounts of unstabilized oxide do not accumulate. The inspection program inspected 212 containers representative of the 1858 noncompliant items to assess their condition and determine appropriate recovery actions. Nine items in the plan have not been inspected yet, because they are stored in the Building 371 Stacker-Retriever, which was inoperable until very recently.
2. Inspections revealed no evidence of past or present pyrophoricity in the containers. The two packages of casting skulls, believed to be potentially pyrophoric, were found to have completely decomposed to plutonium oxide in storage without incident. For other items, the amount of oxide formed in storage varied from essentially none to 100 percent. The principal variables that affected the amount of oxide formed were the type of metal and how well the package was sealed. Storage in "inert" vaults (less than 5% oxygen atmosphere) did little to prevent oxidation of susceptible material/package combinations. Based on these results, SSOC has dispositioned the remaining plutonium metal items as follows:
  - a. Materials which formed little oxide regardless of package configuration will be weighed to establish a baseline and then reweighed every two years to assess oxide formation.
  - b. Packages containing all other categories of material will be opened, inspected, and repackaged in sealed food pack cans to minimize further oxidation (if the item can fit in a food pack can without resizing). Oxide accumulated in the packages will be separated and thermally stabilized. The repackaged metal will be weighed to establish a baseline, then reweighed every two years to assess oxide formation.

As of April 23, 1996, 1044 items had been dispositioned. SSOC expects to disposition all of the plutonium metal packages by the end of FY96. The ultimate disposition of these items is controlled by the DOE implementation plan for Recommendation 94-1, which commits to repackaging them to meet the new DOE standard (DOE-STD-3013-94) for long-term storage of plutonium metal and oxide by May 2002.