

March 7, 2000

Mr. Jack R. Craig, Director
Department of Energy
Fernald Environmental Management Project
P.O. Box 538705
Cincinnati, Ohio 45253-8705

Dear Mr. Craig:

Thank you for briefing the Defense Nuclear Facilities Safety Board (Board) on February 2, 2000, on the chemical safety aspects of the radioactive waste handling and packaging program at the Fernald Environmental Management Project (FEMP). The Board was pleased to learn that the Department of Energy (DOE) and the FEMP contractor, Fluor Fernald, are working to improve the safety planning aspects of the waste management program. The Board believes that the identified upgrades in the characterization of materials, the hazard evaluation process, procedure development, and training will significantly enhance safety during the repackaging and disposal of the site's legacy waste containers. The Board and its staff look forward to reviewing the proposed changes, which we understand will be available by the end of March 2000.

The Board acknowledges the initiatives taken to augment the technical capabilities at FEMP. However, considering that more than 20,000 containers of radioactive waste remain to be treated or repackaged before being shipped offsite, more extensive technical scrutiny in the Hazards Evaluation process may be warranted.

The enclosed report provides a synopsis of the observations of the Board's staff on these subjects, and is forwarded for your consideration. Please contact me if you have any questions on this matter.

Sincerely,

John T. Conway
Chairman

Enclosure

c: The Honorable Carolyn L. Huntoon
Mr. Mark B. Whitaker, Jr.
Mr. David Kozlowski

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

January 6, 2000

MEMORANDUM FOR: G. W. Cunningham, Technical Director
J. K. Fortenberry, Deputy Technical Director

COPIES: Board Members

FROM: W. Von Holle
L. Zull

SUBJECT: Review of Chemical Safety Aspects of Radioactive Waste Handling and Packaging at Fernald Environmental Management Project

This report documents a review of chemical safety aspects of handling and packaging of radioactive waste at the Fernald Environmental Management Project (FEMP). This review, which included a site visit on November 18–19, 1999, was conducted by members of the staff of the Defense Nuclear Facilities Safety Board (Board) W. Von Holle and L. Zull.

Background. The current mission of FEMP is to dismantle the facilities formerly used for uranium and thorium metal processing and waste storage, and to perform environmental cleanup of the site. Since the Department of Energy (DOE) suspended production in 1989, more than 60,000 containers of legacy waste products from uranium refining and thorium processing operations have been repackaged for off-site shipment. About 24,000 more containers remain to be repackaged. Site cleanup activities are scheduled to be completed by 2008.

The review by the Board's staff focused on the ability of the contractor, Fluor Fernald, to adequately identify and develop controls for the chemical hazards involved in the handling and packaging of the remaining containers of legacy radioactive waste. This review was prompted by the recently completed investigation report and final occurrence report regarding the thorium metal chemical reaction and fire that occurred during waste repackaging operations on July 24, 1999.

Thorium Metal Fire. On July 24, 1999, a fire started in a 5-gallon container of thorium metal in Building 65 when the lid was vented with a nonsparking copper punch attached to a front-end loading vehicle. The fire spread to an adjacent 5-gallon thorium metal container whose lid had been vented without incident just prior to the fire. Emergency response personnel soon arrived to contain and extinguish the fire. No injuries resulted from the fire, which was restricted to the immediate area around the waste containers being vented. There was also no measurable uptake of thorium by operations or emergency response personnel, and no release of airborne radioactivity was detected. However, personnel could have been injured if manual venting with hand tools had been attempted, and the fire could have spread to a wider area.

After the event, DOE-FEMP directed the contractor to conduct an investigation and prepare a report. On November 10, 1999, the final occurrence report (OH-FN-FDF-FEMP-1999-0014), incorporating the results of the final investigation report, was issued. According to the occurrence report, the 5-gallon container in which the fire started held about 50 pounds of surface-oxidized thorium metal wafers and other debris. The thorium wafers are 8-inch-diameter disks, $\frac{1}{8}$ to $\frac{1}{4}$ inch thick. The punch penetrated the lid of the container about 6 inches, contacting and causing abrasion of one or more thorium wafers. The contractor's investigation concluded that the fire began when finely divided thorium metal fines produced by the abrasion spontaneously combusted and ignited the wafers, and/or when wafers were ignited by friction from the punch abrading against them.

The Board's staff believes there could have been other causes of the fire. For example, if a container is air-tight, thorium metal may react with moisture to form a metal hydride, which will spontaneously ignite upon being exposed to the air. The contractor presented calculations intended to discredit the hydride mechanism, but supplied no quantitative evidence to support the abrasion ignition mechanism. The staff believes there is insufficient evidence to assign any one cause conclusively, and that prudence dictates a more conservative approach that allows for other possibilities.

In fact, the contractor's investigation report indicated that the root cause of the fire was the failure of the hazard identification process to identify and fully evaluate the potential fire hazards associated with thorium metal. Whether the cause of the fire was abrasion of thorium metal by the punch or spontaneous ignition of thorium hydride, neither mechanism had been identified and fully evaluated during the hazard identification process.

The staff was told that a Process Knowledge Review Panel had recently been established to perform an additional technical review of the uranium and thorium materials in waste containers to support their safe disposition. This panel comprises five individuals with experience in the former uranium and thorium production operations at the site. The staff observed, however, that none of the individuals involved in the hazard identification process or in any review committee, including the Process Knowledge Review Panel, have experience or extensive knowledge of uranium or thorium chemistry. The staff believes the hazard identification process would be improved if a person experienced in the potential hazards of uranium and thorium materials were involved in the hazard analysis of the waste containers.

Implementation of Integrated Safety Management. The contractor has developed a program and procedures to incorporate the principles of Integrated Safety Management (ISM) and associated guidance defined in DOE Policy 450.4, *Safety Management System Policy*, and DOE Guide 450.4-1A, *Integrated Safety Management System Guide*, into radioactive waste handling and packaging operations. However, the root causes of the thorium fire were in essence deficiencies in the implementation of ISM. In addition to the above-noted deficiencies in the hazard identification process, the investigation report identified such problems as insufficient knowledge of materials in waste containers, inadequate procedures, violation of procedures, and inadequate management oversight.

The investigation report identified the direct cause of the thorium metal fire as a defective or inadequate procedure. The procedure requires that small containers be vented by manually uncrimping the lid. However, the 5-gallon thorium container in which the fire occurred had a lever-operated locking ring to secure the lid on the container, a configuration not addressed by the work procedure. In addition, the locking ring on the container was corroded to the extent that the lever was missing, and the lid could not be removed by hand. The work crew reported that they could not vent the container in the manner described in the procedure. Instead, they remotely punctured the lid with the copper punch, which was normally done to vent larger, 55-gallon drums. Unfortunately, the procedure did not prohibit venting small containers with the punch, nor did it provide any discussion related to the technical basis for removing the lid to facilitate venting.

A revised procedure is being prepared for opening four additional containers with thorium metal wafers, similar to the container in which the fire occurred. According to the contractor, the revised procedure will undergo a more thorough hazard evaluation. Violent penetration of the containers with the brass tool is not being considered as an option. According to the Judgment of Needs section of the incident report, several additional actions are being taken, including a formal review of venting procedures by Fluor Fernald site engineering, a revision of the safety assessments, and a technical review of the process for revising procedures. The Board's staff agrees that these actions are needed to improve the implementation of ISM in handling and packaging operations involving radioactive waste and to correct the root causes of the thorium fire.

Operations on the Remaining Waste Materials. Thorium waste handling and packaging operations at FEMP remain halted. Of the remaining containers of low-level waste and residues that remain to be repackaged or overpacked, approximately 20 are considered possibly pyrophoric, and 7,200 are considered to evolve flammable gas. All waste containers to be repackaged are subject to characterization of chemical and radiological wastes, including a review of process knowledge and sampling and analysis. The planned characterization was recently enhanced by the addition of the review by the Process Knowledge Review Panel and additional field verification, including visual inspections and real-time radiography. None of these new techniques was applied to the container involved in the thorium fire. The Board's staff believes these improvements are welcome additions to the safety of operations. However, because of the variability, heterogeneity, and complexity of the thorium and uranium residues, a person with knowledge and experience in the chemical hazards involved or in uranium and thorium materials ought to be involved in the formal hazard analysis of the remaining waste containers. The staff will evaluate FEMP's readiness to resume operations involving handling and packaging of radioactive waste once the contractor has performed its standard startup review.