95-0001232

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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

February 22, 1995

Mr. Mark Whitaker, EH-9
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Dear Mr. Whitaker:

Enclosed for your information and distribution are 13 Defense Nuclear Facilities Safety Board staff reports. The reports have been placed in our Public Reading Room.

Sincerely,

George W. Cunningham
Technical Director

Enclosures (13)

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

September 29, 1994

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: Mark T. Sautman

SUBJECT: Fernald Environmental Management Project - Uranium/Thorium Interim Storage Safety Review Trip Report (September 20-21, 1994)

1. **Purpose:** This report documents a visit by Defense Nuclear Facilities Safety Board (DNFSB) staff to the Fernald Environmental Management Project (FEMP) to review uranium and thorium interim storage safety issues. The review was conducted September 20-21, 1994 and included Mark Sautman, Larry Zull, and Homer Lowenberg (OE).

2. **Summary:** The DNFSB staff has some concerns about the pyrophoric and reactive material stored at the FEMP. Hydrogen explosions caused two drums in 1989 and one in 1992 to violently rupture and blow their lids off. Corrosion of drums storing uranium and thorium is severe. Fernald Environmental Restoration Management Corporation (FERMCO) personnel believe that up to fourteen hundred drums may still be breached. As a result, FERMCO has overpacked or repacked thousands of drums since 1992.

3. **Background:** The FEMP uranium inventory, counting only material with uranium concentrations above the economic discard limit, is about 6600 metric tons uranium (MTU), of which 90% is separated material and the remainder is recoverable residues. Of the separated material, 67% is depleted, 8% is natural, and 25% is enriched (up to 19.9%). The forms of the separated material are metal (54%), UF_4 (33%), and UO_3 (13%). An additional 1600 MTU is contained in over 11,000 MT of low-level radioactive waste (LLRW). The total volume of uranium product, residues, and waste is equivalent to 147,000 55-gallon drums, of which 42% is LLRW. The uranium is predominately stored in 55-gallon drums and 10-gallon cans. Metal fuel element cores are stored in Al-lined wooden boxes and metal ingots (a casting product) and derbies (UF_4 and Mg reaction product) are stored unpackaged on metal and wooden skids.

   The FEMP also has 927 MT of thorium in the forms of thorium nitrate gel (contains 4.3 kg of U-233) and solution, residues, metal, oxides, and other miscellaneous compositions. All of this material is classified as LLRW.

4. Discussion:

a. Hydrogen Generation and Overpressurization: In 1989, two drums containing uranium metal violently ruptured while being moved, blowing their lids eighty feet into the air. In 1992, another drum (overpacked inside two other drums) containing uranium metal exploded during movement, blowing the outermost two lids twenty-five feet into the air. FERMCO personnel believe that in both cases there was a hydrolysis reaction between uranium metal and free-standing water in the drum which produced hydrogen gas. The explosion is believed by them to have occurred due to spark in the drum. Additional bulging drums were discovered afterwards.

In response to these incidents, special procedures were developed for venting and moving drums which may contain uranium metal and water that may be potentially explosive. Safety nets are also required for moving unvented drums from several material codes which may contain free reactive metal or could generate biological gases. The drums requiring safety nets include over two thousand containers which may contain reactive magnesium, which reacts with water to form hydrogen gas. Process knowledge, rather than material characterization, was used to determine which material codes may contain uranium metal, reactive metal, or could generate biological gases. The precautions taken are expected to reduce the likelihood and impact of hydrogen explosions or overpressurization, but the DNFSB staff still has a few safety concerns.

(1) The staff observed a bulging drum which was not vented during a tour. FERMCO personnel stated that this drum did not contain uranium metal, reactive metal, or biological gas generators and thus the bulges were assumed to be due to overfilling or expansion from the freezing of water in the drum. They also indicated that there are many similarly bulged drums. These drums are over-packed, but not vented or covered with safety nets during movement. The DNFSB staff is concerned with this assumption because it is possible that the container's content description could be inaccurate or that metal was unexpectedly disposed of in the drum.

(2) The staff found drums in storage which were labeled "Vented" which did not contain bung vents or obvious vent openings. Upon investigation by FERMCO personnel, some of the plugs were found to be loose, which could allow gas to escape, but others were tight.

(3) Drums potentially containing free reactive metal are considered dangerous enough to require safety nets, yet the drums are not required to be vented.

(4) The use of vent holes could result in the spillage of any liquids that may be in the drum during movement.

(5) The drum vents used have been found to corrode at FEMP and Rocky Flats, which could prevent pressure release.

b. Pyrophoric Materials: Although the FEMP contains uranium and thorium metal, most of this is present as bulk pieces with low surface area to mass ratios. FERMCO personnel have, however, identified 44 uranium and 4 thorium drums which may contain fine pyrophoric material. These drums consist of metal chips and turnings. Some of the vented uranium drums have been filled with water to prevent ignition and promote oxidation. The DNFSB staff believes that this is only a short-term solution because the water may evaporate before all of the metal has been oxidized. Furthermore, the reaction of uranium metal and water produces hydrogen which could react to form uranium hydride, which is also pyrophoric (some of this uranium hydride will be oxidized by water). An argon atmosphere is maintained in the drums of pyrophoric thorium metal.

c. Container Corrosion and Storage Conditions: The DNFSB staff believes that container degradation, especially for drums, is a significant problem at FEMP because containers have been stored unprotected outside. FERMCO personnel stated that the median lifetime of these outside containers is only three years because of the high humidity. Although they are trying to transfer containers into buildings (especially those material types considered to be more hazardous), approximately 23,000 drums are still stored outside, often with little or no protection from the rain. In addition, uranium metal is allowed to be stored outside if it is under a shelter, but these shelters often consist of only a metal roof and minimal siding around the sides which would probably not prevent rain from blowing onto the containers. Furthermore, there are leaks in the roof of Plant 6 which can allow rain to fall directly on the drums and materials below. The presence of leaks is a concern because unprotected uranium metal ingots and skulls were also stored in the same building.

Inspections are used to detect drums with corrosion, leaks, and bulges. A significant fraction of the drums (approximately two-thirds of the drums in Plant 1, the principle storage area) have had to be overpacked because of container degradation. Non-hazardous containers without mass restrictions are stacked three to four drums high and often four across. This arrangement prevents interior drums from being adequately examined.

Preparations are being made to overpack approximately 5600 drums of thorium hydroxides, oxides, and oxalate stored in Building 65 and ship them to the Nevada Test Site (NTS) for burial. These drums date from the 1970s and early 1980s and are in such poor condition that respirators are required in the building. The reason for the severe corrosion is that the drums were stored on plywood sheets rather than pallets. This allowed rain, which came in through holes in the roof and windows (no money was funded for repairs for eight years), to pool and collect around the drums. The Preliminary Safety Analysis Report estimates that up to 1400 drums may have been breached.

d. Future Storage and Disposition: The FEMP was not designed for extensive on-site storage of nuclear material and no safety analysis reports examining uranium storage have been completed. The sheer volume of nuclear material and waste has resulted in containers being stored in the old plants, the pilot plant, warehouses, aluminum huts, tension support buildings, outside shelters, and any free space outside. Few of these locations were designed as storage areas and they have often been used for other activities. This results in a large population of personnel working near the drums, increasing the potential for radiation exposures, contamination spread, and accidental movement of drums into unauthorized configurations. Access has already been limited in some areas because of criticality spacing violations in 1993 and 1994. To correct this situation, Fernald has been trying to consolidate its inventory into buildings designed for storage.

Fernald has been aggressively trying to reduce the inventory of uranium by low-level and mixed waste shipments off-site, Department of Defense transfers, and private industry sales, although sales have recently been suspended by the Secretary of Energy. The inventory has been reduced from 61 million pounds in 1991 to 43 million pounds today. This is predominately due to shipping over 2,000 drum equivalents per week of LLRW to the NTS. FERMCO is also disposing of some mixed waste with Envirocare in Utah and shipping Toxic Substances Control Act (TSCA) waste (i.e., contaminated polychlorinated biphenyl and asbestos) to the Oak Ridge TSCA incinerator. Possible disposition activities that will require guidance from Department of Energy (DOE) - Headquarters include shipments to another DOE site and classifying all the uranium as LLRW or product excess to government needs. Without more off-site shipments or construction of new storage facilities, storage space shortages could cause future decommissioning activities to be delayed because these activities increase the amount of waste generated and reduce the available storage area.

5. **Future Staff Actions:** This review is the second of a series of DNFSB staff reviews of uranium and thorium storage safety issues. The staff plans to conduct further reviews at the FEMP of the Building 65 overpacking project, criticality safety, radiation protection, and material storage conditions during FY95.