Conf-950216--138

WHC-SA-2746-FP

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

MASTER

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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Date Published
December 1994

To Be Presented at
Waste Management '95
Tucson, Arizona
February 27-March 2, 1995

To Be Published in
Proceedings

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DISCLAIMER

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ABSTRACT

This paper describes the deactivation and source term reduction activities conducted over the recent past in two plutonium-contaminated Hanford Site buildings: the 308 Fuels Development Laboratory and the 232-Z Incinerator. Both of these facilities belong to the U.S. Department of Energy, and the projects are unique success stories carried out in direct support of EM-60 functions and requirements. In both cases the buildings, for different reasons, contained unacceptable amounts of plutonium, and were stabilized and placed in a safe, pre-D&D (decontamination and decommissioning) mode.

The concept of deactivation as the last step in the operating life of a facility will be discussed. The need for and requirements of EM-60 transition between operations and D&D, the costs savings, techniques, regulations and lessons learned also will be discussed. This paper describes the strategies that led to successful source term reduction: accurate characterization, cooperation among different divisions within DOE and the Hanford Site, attention to regulations (especially unique in this case since the 232-Z Incinerator has been nominated as a Historic Structure to the National Register of Historic Places), and stakeholder concerns involving the proximity of the 308 Building to the Columbia River. The paper also weaves in the history, missions, and plutonium accumulation of the two buildings. The lessons learned are cogent to many other present and future deactivation activities across the DOE complex and indeed across the world.

DEACTIVATION ACTIVITIES AT THE HANFORD SITE

The Hanford Site, located in southeastern Washington state, was one of America's primary arsenals of nuclear defense production for nearly 50 years beginning in World War II. Approximately 53 metric tons of weapons grade plutonium, over half of the national supply and about one quarter of the world's supply, were produced at Hanford between 1944 and 1989. Today, many Site buildings are undergoing deactivation, an EM-60 activity that is a precursor to decontamination and decommissioning (D&D). The primary difference between the two activities is that equipment and structural items are not removed or torn down in deactivation. However, utilities are disconnected, and special nuclear materials (SNM) as well as hazardous and pyrophoric substances are removed from structures undergoing this process.

308 FUELS DEVELOPMENT LABORATORY

Deactivation was completed as of March 31, 1994 at the Hanford Site's 308 Fuels Development Laboratory (FDL), a 94,000-square foot structure that opened in 1960 to support fuels diversification and modeling in the pre-breeder reactor era. Throughout its active lifetime, the 308 Building was the scene of an almost dazzling array of pioneering developments in fuels technology and fabrication. Primarily a non-defense facility, the 308

Building was the Atomic Energy Commission's (AEC - predecessor agency to the DOE) largest research effort to demonstrate the effectiveness of various PuO_2 and MOX fuels in the "Atoms for Peace" program.[1]

The first fuel mixtures produced in the PFPP (Plutonium Fabrication Pilot Plant - original name for the 308 Building) were metallic, but ceramic fuel blends were being worked in the facility within five years. For a brief time in the late 1960s, neptunium-aluminum alloy fuel target elements and lithium aluminate ($LiAlO_2$) fuel targets were produced in the 308 Building for defense production testing in Hanford's N-Reactor.

However, the building's largest mission came when the Hanford Site was chosen in 1969 as the location for the DOE's prototype advanced sodium cooled reactor (the FFTF) that would develop and test fuels for breeder reactors. The earliest fuels made in the 308 Building for potential use in the FFTF were vibration packed ("vi-pack") powders, but testing demonstrated a low density. This concept soon was discarded in favor of oxide pellet fuel made in the shape of cylinders approximately 3/10" high and 2/10" in diameter. The 308 Building's last mission was repackaging work involving MOX powders for purposes of consolidation This work took place from late 1991 through early 1992.[2]

The decision to deactivate the structure was driven by a 1980s Department of Energy (DOE) decision that plutonium fuels should not be fabricated in areas near the Site's boundaries, as well as by changing facility structural requirements. The 300 Area is located just four miles north of Richland, along the Columbia River, an area of intense interest and concern to regional stakeholders.[3]

Removal of the building's working inventory of plutonium, used in making mixed oxide (MOX) fuel pellets for the Fast Flux Test Facility (FFTF) and other test reactors, took place over the course of a year beginning in mid-1991. Completed in May 1992, this work decreased the yearly security costs for the facility by approximately $3-million. During the peak of its years as a fabrication facility, the 308 Building held as much as 3 metric tons of encapsulated plutonium and approximately 200 kilograms (kg) of MOX powder.

Inventory transfer has been followed by the cleanout and stabilization of plutonium oxide (PuO_2) and enriched uranium oxide (UO_2) residues and powders in the facility's equipment and duct work. This additional effort, along with the transfer of all resident personnel from the building, lowered the annual surveillance budget by another $1 million.

ALPHA CONTAMINATION STABILIZED IN GLOVE BOXES AND HOODS

Over the past three years, a small crew, the remnant of a once-large FFTF fuel supply staff, worked in the 308 Building to wipe, spray and seal the 50 glove boxes and six open-faced hoods that are being left inside the facility until complete D&D occurs at a future date. A majority of the glove boxes are standard size, and contain front and back windows, numerous glove entry ports, equipment doorways and ports, and entryways for electrical and fluid/gaseous services. In these glove boxes, MOX powders and pellets were pressed and then sintered into reactor fuel,

However, six of the glove boxes are approximately 30' long by 3' wide and 3' high, with 40 entry ports and multiple windows, larger equipment ports, and other penetrations. These glove boxes held the furnaces and other large, pilot equipment pieces crucial in the many fuels fabrication research and development activities that were pioneered in the building. The open-faced hoods are approximately 4' long by 3' wide and 3' high, and stand on legs about 4' high. These hoods, although they accumulated alpha contamination, did not provide the level of confinement of a glove box, and so were used primarily for work with uranium materials and processes.

The deactivation crew, after removing much of the instrumentation and other small equipment from the building, donned special anti-contamination clothing and extracted small equipment from inside the glove boxes and hoods. They then performed multiple wipe-downs of the inner surfaces, using damp rags that later were dried and disposed as solid waste. Next, they sprayed the insides of the glove boxes and hoods with a modified acrylic latex, contamination fixant that appears cloudy at first but dries to a nearly clear state. Lastly, they covered all of the glove ports with specially fitted metal plates, and placed over them a polyolefin "shrink-wrap" material that contained an adhesive on the inside. The material is the same as that used to protect welds in industrial pipelines. Using a hot air treatment, they activated the tar-like adhesive so that it melted and flowed into all the crevices between the plates and the ports, thus creating a very rugged seal. The plutonium inventory currently remaining ("held-up") in this equipment totals less than 400 grams.

ATTENTION ALSO GIVEN TO DUCT WORK, TEST REACTOR AND OTHER BUILDING COMPONENTS

In the meanwhile, non-destructive assay was performed on 2,000 feet of duct work in the 308 Building. Although only small amounts of contamination were found, the flanges were caulked with silicone sealants. Lastly, the fasteners on the gaskets were painted with a high-grade interior household sealant. Uncontaminated equipment in the building, such as wire-wrap machines used to spiral wrap the outside of each FFTF fuel pin, pulse magnetic welding (PMW) equipment, and profilometers used to make precise measurements of the outside diameter of finished fuel pins, were either excessed or sent to offsite storage.[4]

The deactivation of a 250-KW (kilowatt) TRIGA (Training Research Isotopes, General Atomics)[1] reactor that was emplaced in Room 162 of the 308 Building's Annex in the late 1970s will occur on a slower schedule. The reactor operated for 13 years to perform neutron radiography testing on fuel pellets and pins, to irradiate materials, and to provide reactor operator training. Currently, the TRIGA's 68 fuel elements have been removed from its core and placed in racks in the water-filled pit or reactor pool. An Environmental Assessment (EA) for the disposition of this spent fuel, which

[1] TRIGA reactors are trademarked properties of the General Atomics Corp., of San Diego, California.

has been irradiated to only a low burnup level (less than 1 percent), currently is under review.

Specially designed irradiated fuel shipping/storage casks are being designed by the staff of the Hanford Site's operating contractor, Westinghouse Hanford Company (WHC). Until the fuel leaves the 308 Building Annex however, regular surveillance of this area will be necessary. Following fuel removal, the control rods, other neutron sources, and some instrumentation will be taken out of the TRIGA and the water pool will be drained. Most of the large, fixed equipment will be left for future D&D.[5]

232-Z INCINERATOR

During 1994 in Hanford's 200-West Area, cleanout of plutonium-bearing equipment, parts and residues took place at the 232-Z Incinerator. Located in the PFP (Plutonium Finishing Plant) complex, the incinerator operated from 1962 through 1973. It was conceived and built as a way to salvage additional plutonium (Pu) that was being buried as residual material on contaminated solid wastes in the late 1950s, a time when the per unit value of plutonium was extremely high.

Candidate wastes for the incinerator included cartons containing contaminated filters, rags, paper, special work clothing, gloves that were not rubber or plastic, and other combustible items used in the PFP and in Hanford's REDOX and PUREX operations. Still more Pu was recovered from non-burnable scrap in one (later two) leach pot(s) in the 232-Z Building. The leachate then was run through solvent extraction processes in the 234-5Z facility to complete the Pu recovery operation.[6]

Preliminary isolation and terminal cleanout activities began in 1982, and continued on a sporadic basis until inspections undertaken in 1989-90 demonstrated the need for more intensive action to stabilize the old facility. At that time, when seismic evaluations demonstrated the 232-Z Building's inability to meet modern criteria, the structure was elevated to high priority status for cleanout. Further, inspections of the duct work and service piping estimated the presence of 848 grams of "held-up" plutonium, levels considerably higher than the "one-third of critical mass" amounts necessary for the facility to be considered "isolated."

The 1994 cleanout was conducted as a joint effort between the WHC Transition Projects and Decontamination and Decommissioning (D&D) organizations. Between January and September, Nuclear Process Operators (NPOs) from the PFP removed moveable equipment, instruments, portions of contaminated piping, duct work and other parts.

At the completion of this effort, the 232-Z Building was left standing, with its five glove boxes, the scrubber (exhaust filtration) cell, the ventilation system, the in-floor filter and the filter box still in place. Approximately 600 grams of Pu were removed, and the effort cost about $1-million.

USQ DECLARED AND RESOLVED

However, just at that point, NDA (non-destructive analysis) undertaken to ascertain the Pu inventory of the incinerator glove box itself still showed the presence of between 1-10 kilograms (kg). Since the amount at the high end of that scale falls outside the confirmed safety boundaries, a USQ (Unreviewed Safety Question) was declared in late August, and administrative controls (including no unnecessary entries) were placed on the 232-Z Building.

Immediately, two separate criticality analyses were launched, to model the situation in the glove box under worst case scenarios. No conditions that could lead to a criticality event were found. Within just a few days, an extensive, independent re-analysis to better characterize gamma and neutron emissions from the Pu was started by a team of national experts in NDA. The team also looked at attenuation (shielding) factors in connection with the approximately 2,900 pounds of fire bricks in the glove box itself.[7]

Using state-of-the-art neutron detection equipment, as well as the long and careful germanium method of gamma detection, the team placed a highly radioactive cesium-137 source at various points outside the glove box to determine and compare their readings. No intrusive entry into the glove box was allowed. Their findings, released in October, demonstrated the presence of only 1-5 kg of Pu.

At the same time, Hanford Site personnel moved to re-study the structural characteristics of the 1962 concrete block building itself. While re-verification took place, consideration was given to placing a heavy steel shroud around the incinerator glove box itself. However, the re-study showed that such a shroud would not be necessary.

In a parallel path, safety re-analysis was taking place. Accident scenarios ranging up to total collapse of the building (with toppling of the glove box) were studied. The outcome of these analyses demonstrated only a 10 percent "release factor" for the glove box itself, but a 100 percent release factor for the building. In other words, should an earthquake occur, only 10 percent of the material in the glove box would be expected to escape the glove box (through two top glove ports), but 100 percent of <u>that</u> material would be expected to escape the building.

Given this result, no further protective actions were required, but WHC decided to install a special new anchoring system for the glovebox as an added safety measure. This anchor assures that the glove box will not topple over under any foreseeable accident conditions. Design, procurement and installation concluded in December. Meanwhile, the USQ was officially resolved.

232-Z FACILITY HISTORIC

Meanwhile, in mid-1994, the 232-Z facility had been named to the National Register of Historic Places due to its unusual equipment design and first-of-a-kind method of automating and executing the incineration of plutonium-bearing combustibles. Opened in 1963, the 232-Z operation surpassed previous Pu scrap burning efforts at other AEC sites in terms of complexity and automation.[8]

Because of its unique past, the 232-Z facility required thorough historic documentation and photographing under the National Historic Preservation Act. A Historic American Engineering Record (HAER) preservation package was rushed to completion during the hectic days right after the USQ was declared and the criticality analysis was completed. The building is now being readied for final cleanout and eventual D&D.

CONCLUSION

In conclusion, the deactivation work carried out at Hanford's 308 Fuels Development Laboratory and at the 232-Z Incinerator demonstrate lessons that are cogent to many other present and future deactivation activities across the DOE complex and indeed across the world. The lessons in techniques of contamination fixation, cooperation among various organizations, attention to regulations and stakeholder views and priorities can be applied elsewhere to stabilize buildings that may have to wait years for D&D but that must be rendered safe for the interim period.

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