

Demolition Of Hanford's 232-Z Waste Incineration Facility

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ABSTRACT

The 232-Z Plutonium Incinerator Facility was a small, highly alpha-contaminated building situated between three active buildings located in an operating nuclear complex. Approximately 500 personnel worked within 250 meters (800 ft) of the structure and expectations were that the project would neither impact plant operations nor result in any restrictions when demolition was complete. Precision demolition and tight controls best describe the project expectations.

The team used standard open-air demolition techniques to take the facility to slab-on-grade. Several techniques were key to controlling contamination and confining it to the demolition area: spraying fixatives before demolition began, using misting systems, frequently applying fixatives, and using a methodical demolition sequence and debris load-out process. Detailed air modeling was done before demolition to determine necessary facility source-term levels, establish radiological boundaries, and confirm the adequacy of the proposed demolition approach.

The ability to perform this demolition safely and without the spread of contamination provides confidence that similar operations can be performed successfully. By removing the major source terms, fixing the remaining contamination in the building, and using controlled demolition and contamination control techniques, similar structures can be demolished cost effectively and safely.

INTRODUCTION

Between 1961 and 1973, Hanford's 232-Z Waste Incineration Facility was used to recover plutonium by incinerating plutonium-contaminated combustible waste. From 1973 through 1983 its mission was waste re-packaging. In 1984, the facility was shut down and entered a long-term surveillance, maintenance and deactivation phase.

In the late 1990s, it was determined that this facility posed a significant hazard to the environment, and efforts began to mitigate the hazard by decontaminating and eventually demolishing the building. During the 22-year deactivation phase, considerable equipment and waste removal activities were performed. In total, over 1300 grams of plutonium was removed from the facility in the form of contamination and held-up material in glove boxes, ventilation ducting, miscellaneous equipment, piping, and debris.

Because of the significant hazard to the environment, decisions (under processes of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA]) were made by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology, (Ecology) to remove/demolish the facility.

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The Tri-Party Agreement Interim Milestone M-83-40, adopted in 2002, required the DOE to “Complete Transition and Dismantlement of the 232-Z Building” by September 30, 2006.

As part of the CERCLA decision process, an engineering evaluation/cost analysis titled, “*Removal of the Contaminated Waste Recovery Process Facility Building*”, was completed and the alternative of demolition to slab-on-grade was selected. The building slab will be addressed as part of future remedial program activities for underground sites throughout Hanford’s Plutonium Finishing Plant (PFP).

In keeping with the CERCLA requirements, the purpose of the 232-Z Demolition Project was to safely demolish, package and properly dispose of all material associated with the 232-Z Facility. The scope of the project was to demolish the 232-Z Facility (Figure 1), leaving behind the slab and the facility’s associated underground appurtenances. Completion criteria required capping the slab to mitigate potential movement of any remaining contaminants to the environment, covering with clean fill, and posting as an underground radioactive material area (URMA).



Fig. 1. This photo shows the 232-Z Facility and nearby buildings before demolition.

FACILITY DESCRIPTION

The 232-Z Facility is located in the Plutonium Finishing Plant's complex that is part of the Hanford Site's 200 West Area. Construction began in 1958 and it was placed into service in 1961.

The building was approximately 11.3 m (37 ft) wide and 17.4 m (57 ft) long. The process and storage areas were in the single-story portion of the structure, and the service areas at the north end were two stories tall. The walls are of cinder block construction and the two roofs are respectively 4.6 m (15 ft) and 5.8 m (19 ft) above grade. The roofs were constructed of concrete over metal decking with insulation and built-up asphalt covering.

The 232-Z Facility was divided into functional rooms and areas, including the following: Process, Chemical Mix, Scrubber Cell, Storage, Change, Ventilation Supply, and Electrical (Figure 2).

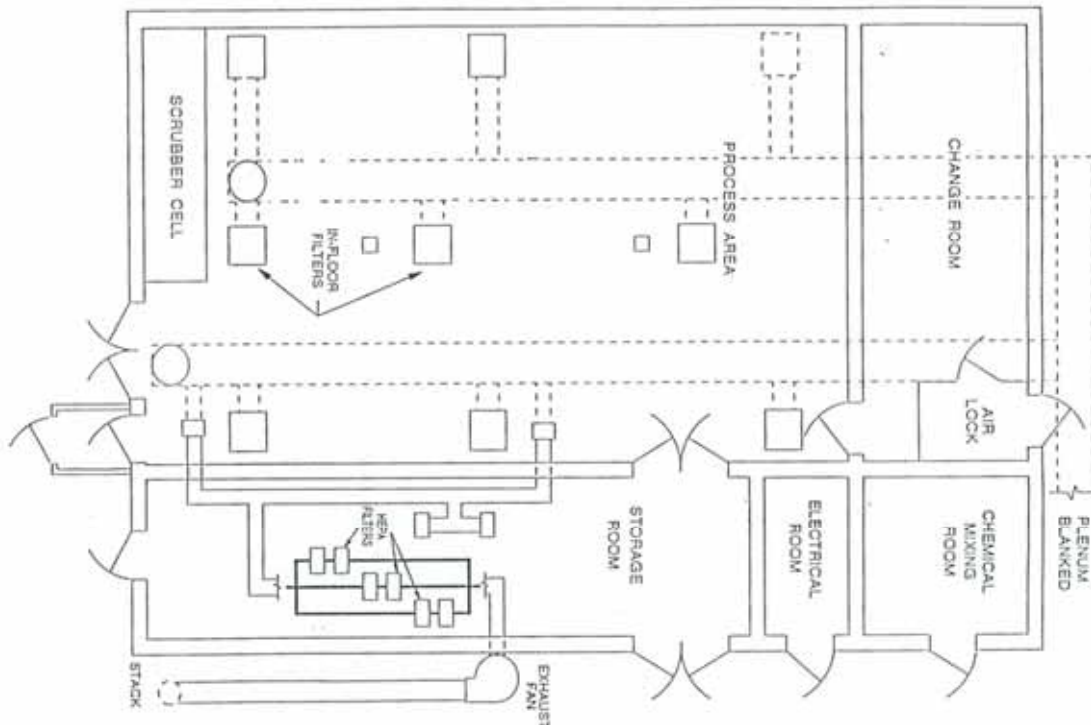


Fig. 2. The 232-Z Facility was divided into several functional areas.

From 1961 until 1973, the 232-Z facility was used to recover plutonium by incinerating plutonium-contaminated combustible scrap material and leaching the non-combustible material. The building housed an enclosed system of gloveboxes and hoods. During operations, off-gases produced from combustion were routed to scrubber equipment and a filter located in the scrubber cell. The gases exited the scrubber cell and passed through high-efficiency particulate air

(HEPA) filters before exiting the building through underground ductwork to the general plant exhaust stack. In 1990, the DOE installed a new, independent ventilation system for the 232-Z Facility. At that time the end of the underground duct was isolated outside of 232-Z.

The facility underwent partial D&D in 1984 with three of the six large gloveboxes being removed. Furnace cleanout continued again in 1994. The majority of the special nuclear material was removed during those deactivation efforts. Between 1994 and 2004, the 232-Z Facility was in a safe and stable surveillance and maintenance mode with controlled access and under a negative pressure. In 2004, deactivation was re-started to remove the remaining plutonium inventory, the remaining gloveboxes, the scrubber cell equipment and the HVAC system, all in preparation for demolition.

The abandoned ventilation system under the 232-Z slab consisted of two, 0.61 m (24 in) transite ducts running the length the building. Branching off the two main ducts are 15, 0.3 m (12 in) collection ducts. The ducts were highly contaminated and fed to another building over 30 m (100 ft) away.

DEMOLITION PREPARATIONS

Demolition planning started in early 2005 with brainstorming sessions utilizing demolition experts from around the DOE complex, along with information from the lessons learned from Fluor Hanford's recent 233-S Facility Demolition. These sessions developed the path forward and actions required to meet the execution strategy.

Several factors were identified that influenced the demolition approach:

- The facility had significant amounts of plutonium contamination
- 232-Z was housed within an operating nuclear complex where approximately 500 people worked on a routine basis
- The building was bordered on three sides by other buildings
- The abandoned ventilation system penetrated the slab in numerous locations
- The 0.61 m (2 ft) diameter abandoned ventilation system lay under the slab
- High plutonium concentrations in the scrubber cell portion of the building

The following sections describe what the team did to mitigate the effects of these factors to allow a safe demolition.

Hold up Removal and Radiological Characterization

The goal was to balance the safety of deactivation efforts to remove plutonium contamination with the safety of demolishing the building with some plutonium contamination remaining. Using the workers to manually remove all (or almost all) of the plutonium held up in various systems was very labor intensive, costly and time consuming. Determining what the demolition effort could safely accommodate and what the deactivation effort needed to remove became an ALARA (As Low As Reasonably Achievable) balancing act between using manual labor to remove contamination and using a machine with a higher risk of contamination spread outside the building footprint. By carefully selecting which deactivation activities removed the largest

concentrations of plutonium-contaminated equipment, and fixing the rest for demolition with the heavy equipment, in the long run, saved considerable time and money, and significantly reduced the hazards to the workers.

Extensive atmospheric-dispersion modeling was conducted by Pacific Northwest Laboratories in Richland, Washington, using ISC3-PRIME (an EPA-developed program) [1, 2]. The ISC3-PRIME was selected because it calculates dispersion patterns considering building wake effects and other meteorological phenomena specific to the site being modeled. The objective of the modeling was to define the potential levels of airborne and soil exposures at surrounding control boundaries. Potential hourly emissions rate of plutonium were estimated for the days with planned demolition and loading activities. An air-dispersion model was used to compute air and surface concentration boundaries for each day of operations, accounting for local building wake effects, atmospheric dispersion climatology, and particle size distribution. The modeling used hourly meteorological data collected over ten years to examine the effects of wind speed, direction, and stability on projected concentrations of contaminants in the air and deposited on nearby surfaces. Using the long-term weather averages for the time frame of the demolition provided concise, defensible, and conservative dispersion pattern limits.

The different phases of demolition were modeled including demolition of the highly contaminated scrubber cell, demolition of the contaminated process room and the loading of debris into roll-off cans.

With the information from the modeling, the project positioned control boundaries for the demolition that provide safe operating distances for the workers and other plant personnel in the area.

Applying knowledge gained from the dispersion modeling and final survey results from previous plutonium contaminated building demolition; factors affecting the results were adjusted to more closely represent actual building conditions. Several of the contributing factors were adjusted: effectiveness of fixatives sprayed on contaminated surfaces, effectiveness of water misting, and the release fraction during demolition.

In compliance with the approved sampling analysis plan, to confirm the basis in the dispersion modeling, and for waste determination, extensive radiological surveys and nondestructive assay (NDA) measurements were performed during the deactivation phase. The total mass of transuranic (TRU) isotopes remaining in the building after deactivation was complete was estimated at 0.98 grams. The distribution and locations are depicted in Table I. The isotopic distribution is summarized in Table II.

Table I. Material that was “Held up” in Various Locations in 232-Z

LOCATION	TRU (grams)
Process Room Walls & Ceiling	0.0423
Process Room Floor	0.12
Scrubber Cell Walls & Ceiling	0.349
Scrubber Cell Floor	0.35
Fan Room	0.114
17” Vacuum	0.002
TOTAL	0.9773

Table II. The Isotropic Distribution for TRU Isotopes for 232-Z

RADIONUCLIDE	WEIGHT %	ACTIVITY %
Pu-238	0.0246	1.38
Pu-239	91.5025	18.58
Pu-240	8.2305	6.11
Pu-241	0.1918	64.67
Pu-242	0.0507	0.0007
Am-241	0.8255	9.26

The demolition boundaries were established using the dispersion modeling and natural barriers (i.e. buildings, roads). The contamination levels within the building dictated that the area of the 232-Z foot print and within a few feet of the building would be considered a High Contamination Area (HCA). Surrounding the HCA, a Contamination Area (CA) was established, then a Radiological Buffer Area (RBA), and finally a demolition boundary for Industrial Safety control of the area.

With contamination readings of up to 1 million dpm/100cm² on the walls and floors of the process room, and readings over a 100 million dpm/100cm² in the scrubber cell, significant care had to be taken to immobilize the contamination. A variety of fixatives were applied to the interior of the building over the life of the building. At the conclusion of deactivation a final fixative coating of Polymeric Barrier System™ (PBS) was applied to the interior surfaces of the building. This proactive measure proved effective at locking in the contamination during demolition.

Other Preparations

The abandoned ventilation system under the slab posed several concerns: 1) collapse of the duct under the weight of the debris and excavator, 2) water entering the duct during demolition, and 3) contamination spread if the duct were breached. The team, with support from Applied Geotechnical Engineering and Construction, Inc., developed and implemented a plan that filled the duct with “flowable” grout to resolve all three of the concerns.

Another precautionary measure implemented was placement of approximately 0.15m (6 in) of sand in the process room and scrubber cell. This served three purposes: to help soften the impact of contaminated debris hitting the floor, to capture excess contamination and water used to control dust. In addition, as a bonus, the sand provided a “filter type” media to trap contamination.

With the closest adjacent building interface just 10 cm (4 in) from 232-Z and the others at 5 m (15 ft) and 7 m (22 ft) respectively, precision demolition and tight radiological controls were required. The closest building had 24-7 operations with no intention of shutting down and was considered a Category 2 Nuclear Facility. To protect the critical components of the building, sheet metal was used to cover piping, conduit, and the walkway to eliminate potential damage due to falling debris and to minimize the potential for contaminating these components. Sheet metal (rather than plywood) had to be used because of fire loading concerns.

Operations in the other two buildings were discontinued during demolition; however, when the project was completed, these buildings were to be returned to fully functional service. Plastic sheeting was draped on the buildings and held in place with industrial-type magnets. Although effective in keeping the buildings radiologically “clean”, the plastic was difficult to place and occasional periods of high winds required some re-work of the plastic sheeting during the project.

Demolition of contaminated structures brings in a set of requirements and conditions that are similar yet drastically variant from standard demolition. The key piece of equipment chosen to perform the demolition was a tracked excavator with a shear. Since this equipment would not be released for unrestricted reuse at the conclusion of the project, the decision was made to procure a new piece of equipment that would perform well on this project as well as many other contaminated structures slated for demolition over the next few years.

DEMOLITION OF 232-Z

Demolition began on June 13, 2006 and the site was stabilized by July 27, 2006. During that period, the building was demolished, 42, 25 m (30 yd) containers of waste material were loaded and shipped, and the area was stabilized for longer-term stewardship.

Dictated by working in tight spaces, the demolition began at the south east corner and then to the scrubber cell (south west corner) (Figure 3). Had the project team had a choice, starting at the least contaminated end and working toward the highest contaminated portions would have been preferred. The waste from the first 5m (15 ft.) of 232-Z was loaded out since this area contained the majority of the hold-up. After the first 5m (15 ft) of the structure were removed and packaged, the remainder of 232-Z was torn down. At that time, the remaining building rubble was packaged and shipped to the disposal facility. During downtimes or at the end of each shift, fixatives were sprayed on any newly exposed building surface or debris.



Fig. 3 Misting equipment was installed on 232-Z, the surrounding buildings, and the demolition excavator.

Demolishing the highest contaminated portion of the building and packaging the debris before demolishing the remainder of the building significantly reduced the potential for contamination spread.

Dust Control

The proximity of the other buildings and the lack of soil around the building heightened the concern over water control. Too little water would make it difficult to contain the dust, and therefore, the potential spread of contamination. Too much water and the project would spend additional resources and time processing the excess water. To balance this situation, an FOGCO® high- pressure misting system was deployed to engulf 232-Z in a cloud of mist. Nozzles were strung on the nearby buildings and across the 232-Z roof. The nozzles on the 232-Z roof were intentionally sacrificed as the building was systematically demolished. Figure 3 shows the misting system operating during the demolition.

In addition to the nozzles installed to surround the building, an FOGCO® (trademark of FOGCO Systems, Inc.), high pressure misting system was installed on the demolition excavator. The tank and pumps were placed near the cab and hoses ran down the boom to the misting nozzles located near the shear end effector. The nozzles were designed such that they could be easily replaced should they become damaged during the demolition. Figure 3 shows the excavator misting system in action at the start of the scrubber cell demolition.

The misting worked very well at keeping the area moist and dust and contamination within the CA. However, when wind speeds exceeded 13 km/hr (8 mph), the misting effectiveness was greatly diminished but overall contamination control was still adequate.

Dust suppression using fire hoses also complimented the misting efforts for “point specific” locations. For this project, it was critical not to “over do” use of the fire hoses as excess water had to be collected and disposed of. The combination of the misters and the fire hose worked well in keeping contamination within the immediate demolition area. The day the scrubber cell was demolished, Mother Nature provided some additional coverage that proved effective. The light rain and calm winds, in combination with the misting and point spray application, provided an impermeable barrier to the alpha contamination.

Radiological Controls

Radiological controls established to protect the workers, adjacent facilities, and plant personnel mitigated the potential spread of contamination outside the CA. The CA boundary was placed approximately 13 m (40 ft) from the west, east, and south edges of the building. To the north, the CA boundary was placed approximately 5m (15 ft) from the edge of the building since there was no pre-existing contamination found in the north 6m (20 ft) of the building.

Work activities in the CA required personal protective equipment (PPE) that included a single set of coveralls, waterproof rain gear, a Power Air Purifying Respirator (PAPR) with hood. A lapel air sampler was required for personnel monitoring.

Weather conditions were continually monitored via a nearby weather station and wind socks to ensure the demolition was conducted within the guidelines established to control the spread of contamination. The maximum wind speed allowed per our procedures during demolition and waste load out operations was 20km/hr (12 mph).

In addition, weather conditions were also monitored for the Wet Bulb Globe Temperature, as heat became a huge factor in limiting work efforts due to high ambient temperatures. The project adjusted the work shift from first shift to a graveyard shift to mitigate the effects of extreme daytime temperatures.

Project air monitoring consisted of four Continuous Air Monitors (CAMs) and four fixed head air samplers. The CAMs were placed to the north, west, east, and south of 232-Z at the edge of the CA. Four fixed head air samplers were placed at areas deemed necessary by the radiological control group. In addition to the air sampling devices, ten fixed plate survey stations were placed along the perimeter of the CA boundary.

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During the demolition and load out of debris, the following data was collected:

- 214 grab air samples were pulled
- 154 Alpha Sentry Cam filters were read
- 158 required radiological surveillances performed
- Over 245 lapel samples pulled over a 45 day period

The significant amount of data collected provided the project evidence that no contamination spread occurred outside the CA and there were no personnel contamination events.

On completion, the building slab was coated with a fixative and covered with approximately 12” of gravel (Figure 4). The area was posted as an Underground Radioactive Material Area.



Fig. 4. When the project was completed the facility had been removed and a cap installed to prevent contamination from migrating to the environment.

WASTE LOAD OUT

After the building was sized reduced to meet the waste criteria, the demolition debris was loaded into pre-prepared 25 cubic meter (30 yard) roll off containers using a front end loader. The containers were prepared with liners and absorbent and then placed into the contamination area. To keep the container shuttle truck and the exterior of the containers radiologically clean, heavy plastic was rolled from the clean area into the CA to accommodate both the truck and container placement. The plastic road allowed a significant reduction in survey time prior to removing the container from the CA. The entire building was designated as low-level waste (LLW) and was disposed in Hanford's Environmental Disposal Facility (ERDF). In total, 42 roll off waste containers were filled with all the building debris and associated soils disturbed during demolition.

LESSONS LEARNED

Noteworthy lessons that can be applied to future demolition activities are key to improving on the existing process. The lessons the project found to be noteworthy are provided below.

- *Fixative Applications are Effective* – The existing fixative and the PBS sprayed just prior to demolition proved effective. Furthermore, the fixatives applied during demolition, kept contamination locked down during loading and periods of inactivity.
- *Misting Devices and Water are Effective at Controlling Contamination* – The misting devices on and surround the building and on the shear controlled the dust and contamination. The fine mist performed well at capturing airborne particles and keeping them within the confines of our radiological boundaries. One down side to the misting is that during breezy periods, the effectiveness is reduced.
- *Dispersion Modeling Helped in Setting Radiological Boundaries and Provided a “Level of Comfort” for Plant Personnel* – The dispersion modeling supported our efforts to perform open air demolition, helped in setting boundary locations, picking demolition methods, and provided a “level of comfort” based on hold up and demolition methods. The modeling tends to be conservative; however, the project did revise the modeling based on actual conditions for future use in dispersion modeling.
- *Removal of Highly Contaminated Debris Before the Remainder of the Building was Demolished Greatly Reduced the Potential for Contamination Spread* - Removing/packaging the highly contaminated material contained in the scrubber cell before demolishing the remainder of the building reduced contamination spread, the contamination of the demolition equipment, and airborne concerns. This was dictated in part, by the dispersion modeling.

SUMMARY AND CONCLUSIONS

This project represents the second successful open-air demolition of a highly plutonium-contaminated facility accomplished by Fluor Hanford. The decisions made with respect to performing open-air demolition without decontamination to near free release standards provided a successful mix of ALARA to the workers while accomplishing a safe, cost effective, and efficient demolition project.

REFERENCES

1. B.A. Napier, J.G. Droppo. “2005 Analysis of Radioactive Releases during Proposed Demolition Activities for the 232-Z Building”, Letter Report to Fluor Hanford, Pacific Northwest National Laboratory, Richland, WA (2005).
2. B.A. Napier, J.G. Droppo. “2006 Addendum to Analysis of Radioactive Releases During Proposed Demolition Activities for the 232-Z Building”, Letter Report to Fluor Hanford, Pacific Northwest National Laboratory, Richland, WA (2006).