HNF-33983-FP
Revision 0

Radiological Controls for Plutonium Contaminated Process Equipment Removal from the 232-Z Contaminated Waste Recovery Process Facility at the Plutonium Finishing Plant

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR®
P.O. Box 1000
Richland, Washington

HNF-33983-FP
Revision 0

Radiological Controls for Plutonium Contaminated Process Equipment Removal from the 232-Z Contaminated Waste Recovery Process Facility at the Plutonium Finishing Plant

A. M. Hopkins
M. S. Gerber
D. B. Klos
M. J. Minette
S. C. Snyder
Fluor Hanford

E. R. Lloyd
J. A. Teal
Fluor Government Group

S. L. Charboneau
Department of Energy - Richland Operations Office

Date Published
May 2007

To Be Presented at
2007 ANS Decommissioning, Decontamination & Reutilization

American Nuclear Society, ANS
Chattanooga, TN

September 16, 2007

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR®
P.O. Box 1000
Richland, Washington

J. D. Aardal — Release Approval   05/30/2007 — Date

Printed in the United States of America

RADIOLOGICAL CONTROLS FOR PLUTONIUM CONTAMINATED PROCESS EQUIPMENT REMOVAL FROM THE 232-Z CONTAMINATED WASTE RECOVERY PROCESS FACILITY AT THE PLUTONIUM FINISHING PLANT

A. Hopkins, M. Gerber, B. Klos, M. Minette, S. Snyder
Fluor Hanford, Inc. PO Box 1000 Richland, WA 99352,

E. Lloyd, J. Teal
Fluor Government Group. PO Box 1000 Richland, WA 99352

S. Charboneau
US Department of Energy, Richland Operations Office, PO Box 500, Richland WA 99352

INTRODUCTION

The 232-Z facility at Hanford's Plutonium Finishing Plant operated as a plutonium scrap incinerator for 11 years. Its mission was to recover residual plutonium through incinerating and/or leaching contaminated wastes and scrap material. Equipment failures, as well as spills, resulted in the release of radionuclides and other contamination to the building, along with small amounts to external soil. Based on the potential threat posed by the residual plutonium, the U.S. Department of Energy (DOE) issued an Action Memorandum to demolish Building 232-Z, *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) *Non-Time Critical Removal Action Memorandum for Removal of the 232-Z Waste Recovery Process Facility at the Plutonium Finishing Plant* (04-AMCP-0486) .

The deactivation, decontamination and demolition (D&D) of the facility required the development of many innovative radiological monitoring and control methods. The needs for these new methods were driven by the unique challenges inherent in the D&D project:

- Highly mobile/readily airborne plutonium ash (fly ash)
- Highly contaminated scrubber cell room
- Desire to perform open-air demolition in close proximity to other nuclear operations
- Gloveboxes and process equipment with many inaccessible surfaces

The open-air demolition of the building was completed in July 2006 with outstanding results; no skin contaminations, no inhalation events and no release of contamination beyond the modeled contamination area boundary.

232-Z CONTAMINATED WASTE RECOVERY PROCESS FACILITY

The 232-Z Contaminated Waste Recovery Facility was designed to recover plutonium from process wastes such as rags, gloves, containers and other items by incinerating the items and dissolving the resulting ash. The furnace incineration operations started in 1961 and continued through 1973. During that period, multiple operating disruptions resulted in contamination of the process gloveboxes and scrubber-cell equipment, as well as the release of plutonium fly ash into the processing room and ventilation systems.

Some plutonium fly ash in the original building's ventilation system had migrated past the process high-efficiency particulate air (HEPA) filters that exhausted process equipment. In 1990, a new ventilation system was attached to the 232-Z facility and the ductwork connecting 232-Z to the 291-Z building was isolated. The inactive 232-Z exhaust system contained up to 19 grams of Plutonium and would require stabilization during the deactivation of the 232-Z building.

The hold-up material inside the building included over 1300 grams of plutonium fly ash in process equipment, and ventilation systems and on the walls of the highly contaminated scrubber cell. To prepare the building for open-air demolition, all but one gram of plutonium had to be removed.

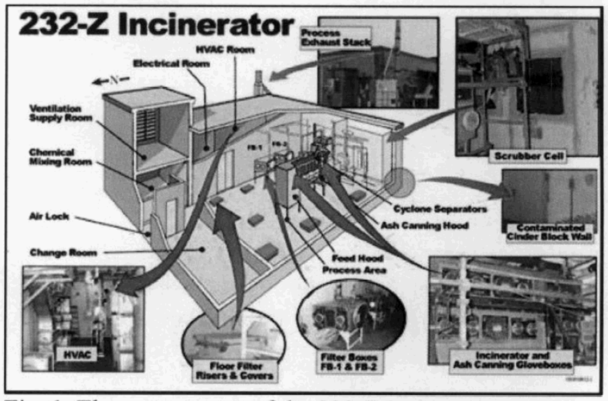

Fig. 1. The components of the 232-Z Incinerator were highly contaminated.

The 232-Z building was approximately 11.3 m wide and 17.4 m 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 were of cinder block construction and the two roofs were respectively 4.6 m and 5.8 m above grade. The roofs were constructed of concrete over metal decking with insulation and built-up asphalt covering.

DESCRIPTION OF THE D&D PROJECT

The 232-Z D&D work was divided into five main phases. The first phase was the radiological air modeling to determine the control necessary to demolish the building using open air demolition methods. The second phase was removing the contaminated process equipment including the incinerator glovebox. The third phase was the cleaning out the highly contaminated scrubber cell. The fourth phase was removing the ventilation system. The fifth and final phase was the open-air demolition of the building.

Radiological Air Modeling

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. Allowing workers to manually remove almost all of the plutonium hold-up in systems was risky, very labor intensive, costly and time consuming. Determining the conditions for safe demolition and the efforts needed to remove the plutonium became an ALARA "balancing act" between using manual labor to remove contamination and using demolition machines. By carefully selecting the deactivation activities that would remove the largest concentrations of plutonium-contaminated equipment, and fixing the rest for demolition with the heavy equipment saved considerable time, money, and significantly decreased the hazards to the workers.

Extensive atmospheric dispersion modeling was conducted by Pacific Northwest National Laboratory, using ISC3-PRIME (EPA-developed program). The ISC-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 exposure at surrounding control boundaries. Potential hourly plutonium emission rates 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 air and deposited on nearby surfaces. Using the long-term weather averages for the time frame of the demolition provided concise, defendable, 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. Information from the demolition of 233-S and dispersion modeling provided information to adjust the following: effectiveness of fixatives sprayed on contaminated surfaces, effectiveness of water misting, and the release fraction during demolition. With the information from the modeling, the project positioned control boundaries for the demolition that provided safe operating distances for the workers and other plant personnel in the area.

Process Equipment Removal

The majority of the facility's hold-up material was located in the incinerator glovebox. "Sawzalls" and "portabands" were used to remove the internal furnaces, cyclones, conveyors and remaining process equipment from the inside of the glovebox. Ventilation controls remained on the glovebox throughout all the internal cleanout efforts.

Once the internal cleanout of the incinerator equipment was complete, the internal surfaces of the glovebox were decontaminated using commercial decontamination chemicals. The plan was to decontaminate the glovebox to low-level waste standards and then dispose of the glovebox as a single unit. Although PFP has had good experience with decontaminating plutonium contaminated gloveboxes and hoods problems with the incinerator glovebox were identified after the first decontamination cycle. Sealed penetrations in the glovebox and channel sections that could not be exposed prevented the decontamination solutions and mechanical scrubbing from removing some the plutonium. Efforts to expose these areas and decontaminate the metal to the low-level waste limits were not successful after three cycles, so the glovebox was removed and sent to the central size-reduction facility.

Scrubber Cell Cleanout

With the glovebox removed, the team could enter the scrubber cell for the first time in 15 years. The ability to characterize the scrubber cell from the outside was very limited, so substantial controls such as tenting, additional filtered ventilation exhausters that exchanged the air in the cell every 2 minutes, supplied-air protective clothing, and extensive air monitoring were in place prior to the first entry. The opening of the scrubber cell door showed that disturbing any surface inside the cell could result in significant airborne contamination of over one million derived air concentration (DAC). The cell was fogged and sprayed with a fixative prior to the initial entry and then routinely fogged to ensure surfaces were wetted during future entries.

The monitoring of air contamination was conducted using Canberra Alpha Sentry CAMs ™. Three alarming units were placed in the containment tent, the anteroom and in the process room. A fourth Alpha Sentry CAM was connected to the scrubber cell exhaust as a cell environment monitoring system. The scrubber cell CAM had the alarm deactivated and was connect to a remote Alpha Sentry Monitor™. Radiation Control Technicians would monitor the DAC hour changes to the scrubber cell every fifteen seconds and these changes were communicated to the workers inside the cell to help them know when additional contamination controls (such as fogging and fixing) were necessary. The Radiation Control Technicians also notified the scrubber-cell worker when the airborne concentrations were reaching administrative action levels that required an orderly exit of the scrubber cell.

Lapel samplers were placed inside the containment suits to verify the conditions in the worker's breathing air space.

Fig. 2. Workers don personal protective equipment before entering the scrubber cell access tent.

As cleanout continued, the deactivation team found plutonium fly ash outside the scrubber equipment and hidden in sections of the filter boxes.

Core sampling of the cinderblock walls, paint sampling and sodium iodide gamma surveys of the walls were used to determine when the scrubber cell was clean enough for open air demolition. In all, the team completed 104 entries into the high-hazard scrubber cell to remove all the air handling equipment and decontaminate the room to low-level waste standards.

Ventilation System Removal

The air modeling had determined that all the ventilation ducting up stream of the process HEPA filters had to be removed due to the high plutonium gram qualities in the piping. Further, all the HEPA filters (both in boxes and the floor filters) had to be removed, because even low quantities of plutonium in the HEPA filter media would disperse beyond the acceptable control boundaries.

Removing the duct required cutting inside glove bags. The filter boxes had to be size reduced within a containment tent. The environment inside the size-reduction tent was monitored continuously for changes in the levels of airborne contamination.

Open-Air Demolition

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 was put in place.

With contamination readings of up to 1 million dpm/100cm^2 on the walls and floors of the process room and readings over a 100 million dpm/100cm^2 in the scrubber cell, significant care had to be taken to immobilize the contamination. At the conclusion of deactivation a final fixative coating of Polymeric Barrier System ™ (PBS) was applied to the building's interior surfaces. This proactive measure proved effective at locking in the contamination during demolition.

Another precautionary measure implemented was placement of approximately 0.15m of sand in the process room and scrubber cell. This served two purposes: help soften the impact of contaminated debris on the floor and capture excess contamination and dust-control water. As a bonus, the sand provided a "filter type" media to trap contamination.

With the nearest building interface just 10 cm from 232-Z and the others at 5 and 7 m respectively, precision demolition and tight radiological controls were required. The closest building had 24-7 operations with no intention of shutting down and is considered a Category 2 Nuclear Facility. To protect the critical components of the building, sheet metal was used to cover piping, conduit, and the walk way 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 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 high winds did require some re-work during the project.

The proximity of the other buildings and the lack of soil around the building heightened the concern over water control. Too little water would be difficult to contain the dust and therefore the contamination. Too much water would require the project to spend more time dealing with excess water than demolishing the building. To balance this situation, a 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. Radiological controls established to protect the workers, adjacent facilities, and plant personnel prevented the spread of contamination outside the CA.

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

The air was constantly monitored by 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 scattered around the CA boundary.

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

- 214 grab air samples
- 154 Alpha Sentry Cam filters were read
- 158 radiological surveillances
- Over 245 lapel samples over a 45 day period with only one elevated reading.

RESULTS/LESSONS LEARNED

There were many lessons learned relative to radiological control during the 232-Z incinerator D&D project.

- The use of continuous radiological monitoring with immediate feedback for changing conditions is crucial for working in high DAC plutonium environments.
- Decontamination solutions are effective in cleaning process equipment to low-level waste criteria only if the plutonium holdup surfaces can be accessed.
- The existing fixative and the PBS sprayed just before demolition was effective. Furthermore, the fixatives applied during demolition kept contamination locked down during loading and periods of inactivity.
- The misting devices on and surrounding 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. During breezy periods, the effectiveness of misting is reduced.
- 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 parameters based on actual conditions for future use in dispersion modeling.

REFERENCES

1. E.R. LLOYD, M.J.MINETTE, et al., "Demolition of Hanford's 232-Z Waste Incineration Facility," Tucson, Arizona (2007)
2. M. J. MINETTE, A. HOPKINS, B. KLOS, "Contaminated Process Equipment Removal For The Deactivation And Decontamination Of The 232-Z Contaminated Waste Recovery Process Facility At The Plutonium Finishing Plant", Tucson, Arizona (2007)