Contaminated Process Equipment Removal for the Deactivation and Decontamination of the 232-Z Contaminated Waste Recovery Process Facility at the Plutonium Finishing Plant

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ABSTRACT

This paper describes the unique challenges encountered and subsequent resolutions to accomplish the deactivation and decontamination of a plutonium ash contaminated building. The 232-Z Contaminated Waste Recovery Process Facility at the Plutonium Finishing Plant was used to recover plutonium from process wastes such as rags, gloves, containers and other items by incinerating the items and dissolving the resulting ash. The incineration process resulted in a light-weight plutonium ash residue that was highly mobile in air. This light-weight ash coated the incinerator's process equipment, which included gloveboxes, blowers, filters, furnaces, ducts, and filter boxes. Significant airborne contamination (over 1 million derived air concentration hours [DAC]) was found in the scrubber cell of the facility. Over 1300 grams of plutonium held up in the process equipment and attached to the walls had to be removed, packaged and disposed. This ash had to be removed before demolition of the building could take place.

Removing the process equipment required containment tenting for the equipment in the process room, and the use of fresh air suits for entries by personnel into the highly contaminated scrubber cell. The highly mobile plutonium ash complicated all tasks for removing and packaging. Even the smallest hole in the containment would result in the contamination of the whole process room.

Many of the areas in the incinerator building could not be readily accessed or fully characterized prior to the effort to remove process equipment. Often as equipment was opened, or filters were removed, large piles of the highly mobile ash would be exposed. Given these conditions, processes were developed to monitor for and control risks as they emerged and developed in the equipment removal process.

The Contaminated Waste Recovery Process Facility (232-Z) began operations on January 8, 1962, and operated for approximately 11 years. Its mission was to recover residual plutonium through incineration and/or leaching contaminated scrap material. Equipment failure, as well as spills, resulted in the release of radionuclide and other contamination to the building, along with small amounts to external soils. Based on the potential threat posed by the residual plutonium, the U.S. Department of Energy, Richland Operations

Office (DOE-RL) issued an Action Memorandum under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* to demolish the 232-Z facility.

The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Action Memorandum for the 232-Z Waste Recovery Process Facility* (04-AMCP-0486) required the DOE to remove contaminated equipment and demolish the building to a slab-on-grade condition. Debris was to be disposed primarily to the Hanford Site's Environmental Restoration Disposal Facility (ERDF). The building slab was to be characterized and sealed as needed to prevent exposure to any residual contamination. The scope of the Action Memorandum included isolating the underground ductwork between 232-Z and the 291-Z (ventilation stack) buildings.

The work performed to address the goals of the Action Memorandum is documented in the Daily Reports prepared by the Deactivation and Demolition Superintendent and Demolition Leads. As stipulated in the Action Memorandum, process equipment was removed from the facility and packaged for disposal. After the asbestos was removed, the interior surfaces were painted to fix loose contamination, floor penetrations were grouted and sealed, and the building was demolished. The underground ductwork between 232-Z and 291-Z was grouted. Building debris was packaged and sent to the ERDF for disposal, or if the material were transuranic, packaged and stored for later disposal to the Waste Isolation Pilot Plant located in New Mexico. One glovebox was packaged for further size reduction at another location prior to disposal. The building slab was sealed to fix residual contamination and covered with gravel to protect the building slab from wind and weather erosion. The *232-Z Building Final Slab-on-Grade Characterization Report* (M2300-06-010) documents the radiological and hazardous constituents at this facility before and after demolition.

INTRODUCTION

The 232-Z Contaminated Waste Recovery Process Facility (232-Z) at the Plutonium Finishing Plant (PFP) was used to recover residual plutonium through incinerating and/or leaching contaminated scrap material (Figure 1). The operational history of the facility indicates that equipment failure, as well as spills, resulted in releasing radionuclide and other contamination to the building and external soil. The facility was unused for approximately 20 years, and the U.S. Department of Energy (DOE) determined there was no ongoing need for the building. Based on the potential threat posed by the residual plutonium in this facility, the DOE, Richland Operations Office, performed an *Engineering Evaluation/Cost Analysis for the Removal of the Contaminated Waste Recovery Process Facility Building 232-Z* (DOE/RL-2003-29) [1] (EE/CA) and determined that it was appropriate to remove Building 232-Z to slab-on-grade. This decision was documented in November 2004 through the *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) [2].

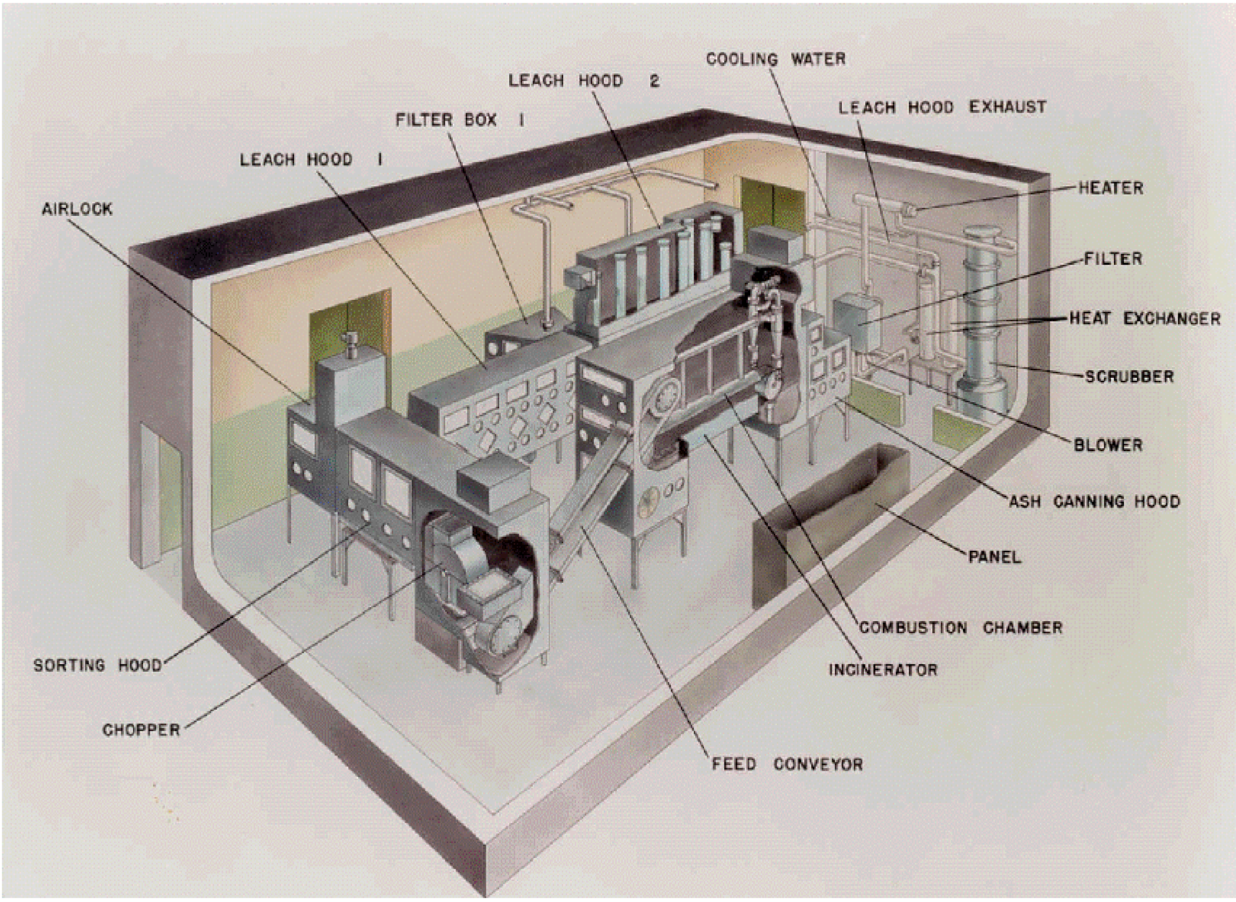

Figure 1. The 232-Z Contaminated Waste Recovery Facility leached and incinerated plutonium waste to recycle the residual plutonium. This view shows the operating layout for the building background.

BACKGROUND

The 232-Z Contaminated Waste Recovery Process Facility is located at the Plutonium Finishing Plant at DOE's Hanford site. The 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 disruptions in operations resulted in contaminating the process gloveboxes and scrubber cell equipment, as well as releasing plutonium fly ash into the processing room and ventilation systems.

For the next decade, the building was used mainly for waste repackaging operations. In 1984, deactivation work started in the 232-Z process room with the removal of the chopper glovebox and the two attached leach hoods. Also, work to remove packages that contained special nuclear material (SNM) from the building was completed over the next decade.

The plutonium fly ash in the original building ventilation system had migrated past the process high efficiency particulate air (HEPA) filters. In 1990, a new ventilation system was installed on the 232-Z facility and the ductwork connecting 232-Z to the 291-Z building (the PFP common ventilation stack) 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 inactive portion of the system that remained after the installation of the new stack is located mostly underground.

In 2002, the DOE, the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (WDOE) established a time table for the deactivation and demolition of the Contaminated Waste Recovery Process facility. The *Hanford Federal Facility Agreement and Consent Order* (HFFACO) [3] Interim Milestone M-83-40 required the DOE to "Complete Transition and Dismantlement of the 232-Z Building" by November 30, 2006. The DOE, EPA and WDOE also agreed that deactivation of the 232-Z facility could start before the action memorandum was issued.

Completing the 232-Z deactivation startup readiness review began the final effort to deactivate, decontaminate and demolish the 232-Z facility. The main incinerator glovebox, scrubber cell, furnaces and ventilation systems were still in the building along with over 1300 gram of plutonium when activities restarted. A building diagram is shown in Figure 2.

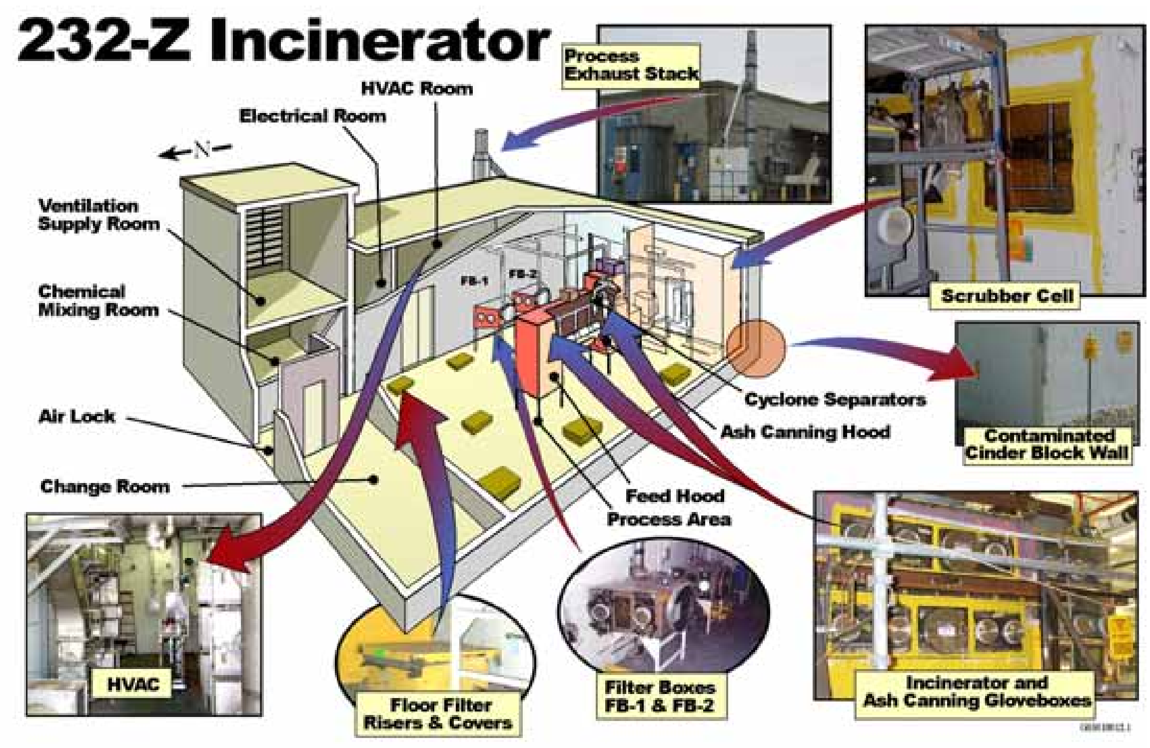

Figure 2. This figure is a cutaway diagram of the 232-Z facility prior to final deactivation.

CERCLA DOCUMENTATION

On such a fast track project, the timely completion of the CERCLA authorization and documentation process was critical to the success of the project. The deactivation activities were initiated under a regulatory pathway defined in Hopkins et al, 2003 [4] that ensured compliance with appropriate regulations. Subsequently, the remainder of the deactivation and decontamination work was accomplished under the CERCLA which allowed for an accelerated approach including frequent interfacing with the Ecology Project Manager for this action.

AREA OF RESPONSE ACTION

On November 5, 2004, the DOE/RL issued a CERCLA Action Memorandum for removing the 232-Z Contaminated Waste Recovery Process Facility. Ecology signed the document on November 9, 2004. The removal plan implementing the action memorandum included stabilization of the internal building contamination and remaining equipment, followed by building demolition and removal, and disposal of building rubble at ERDF. The removal action included the following requirements:

- Ensure all waste generated is managed and packaged to meet the waste acceptance criteria for ERDF or the Hanford Site's Central Waste Complex (CWC)

- Ensure all activities are managed to meet federal and state *Clean Air Act* criteria

- Ensure all penetrations of the building slab are sealed and the concrete is coated with a fixative to prevent exposure or release from residual contamination

- Ensure the removal scope includes a section of ductwork in the 291-Z Exhaust Building basement and characterization of radionuclide contamination in the below-grade ductwork connecting the 231-Z and 291-Z buildings

- Ensure that a removal action work plan and all supporting documentation are prepared prior to commencing the removal action.

The 232-Z building slab itself will be remediated under future CERCLA activities, along with the underground ductwork and contaminated process lines from the building, as well as any adjacent soil contamination.

The *Removal Action Work Plan (RAWP) for the 232-Z Contaminated Waste Recovery Facility* (DOE/RL-2004-61) [5] (RAWP) for the removal action was issued on November 29, 2004, and approved by Ecology on December 17, 2004. The final end point for the demolition of Building 232-Z, specified in the *Plutonium Finishing Plant (PFP) Complex End Point Criteria* (HNF-22401) [6] for the D&D Project, was stabilized "slab-on-grade." Milestone M-83-00A, *Complete PFP Facility Transition and Selected Disposition Activities*, of the HFFACO documented this end point for facilities pending final disposition at the PFP site. The RAWP provides a description of the removal action including the following components:

- Mobilization and site preparation
- Characterization for work implementation
- Removal or stabilization of work activities
- Building demolition
- Facility hazards
- Structures, systems, and components that protect workers
- Specialized project equipment.

The RAWP also included Safety and Health Management and Controls; Environmental Management and Controls; Project Management and Organization; Project Closeout; and Appendices that addressed the Sampling Approach, Basis of Estimate, and Project Schedule.

The *232-Z Site Specific Health and Safety Plan* (HNF-20848) (HASP) [6] included chemical and radiological hazard identification and evaluation, organizational roles and responsibilities, hazard mitigation and control, monitoring requirements and instruments, training and personnel protective equipment (PPE), and other components that ensured personnel safety during the decontamination and deactivation process. A review of the Daily Reports from the construction period indicates that these requirements were complied with, as evidenced by work stoppages associated with elevated contamination levels, modifications to PPE to address site needs, and regular training updates to ensure personnel were aware of ongoing exposure concerns.

The *232-Z Contaminated Waste Recovery Process Facility Waste Management Plan* (HNF-20862) (WMP) [6] identified the candidate waste streams anticipated in the course of the removal action. The WMP included the approach to be used for waste characterization, designation, minimization, handling, storage, and packaging. The document also included options for waste treatment and disposal. Attachments to the WMP included a checklist for waste container storage inspection and onsite shipping. The WMP was supplemented by the development of the *232-Z Contaminated Waste Recovery Process Facility Demolition Plan* (HNF-20890) [7].

DEACTIVATION

The objective of the deactivation phase of the 232-Z project was to remove enough plutonium in process equipment to allow the facility to be disposed of as low level waste (LLW) and to be demolished using open-air demolition methods. Air modeling of the buildings and the facilities that surround 232-Z identified that the portions of the facility to be demolished could contain only 1 gram of plutonium and comply with contamination area deposition requirements. Had the surrounding operating facilities not been so close, the low level waste criteria would have been the limiting factor and more plutonium could have been left in the building rubble. Knowing when deactivation was complete and when open-air demolition could start was critical for planning and decision making during this phase of the project.

The following list gives the sequence of deactivation:

- Remove the furnaces and equipment from inside the gloveboxes
- Decontaminate and remove the gloveboxes
- Remove the equipment from the highly contaminated scrubber cell
- Remove the ventilation system and HEPA filters
- Stabilize the inactive underground duct floor filters
- Decontaminate the facility and fix remaining contamination, and
- Isolate the building from all energized systems.

The removal of the furnaces, conveyor, piping and the cyclone air separators from the inside of the gloveboxes started in 2004. Because of the size of the seal-out ports, components were sized reduced in the glovebox prior to waste packaging. The heavy metal equipment also hid the plutonium fly ash from the early non destructive analysis (NDA) conducted on the glovebox components. Significant build up of ash in the cyclone separator required altering waste packaging methods and significantly added to the cleanout effort. New protocols were used to NDA the remaining accessible equipment in the facility to support planning.

A result of the new NDA was that additional regulator controls were necessary in order to proceed to demolition with the higher plutonium gram value in the building. This resulted in a six month delay while the plant personnel obtained a major stack air permit. Shortly after the air permit was approved, the 232-Z Action Memorandum was issued, so later challenges encountered during deactivation were quickly resolved at the routine project manager meetings with the regulators.

The glovebox was then decontaminated with the goal of cleaning the glovebox to LLW so it could be shipped whole to ERDF which is a CERCLA disposal site. While flat and accessible surfaces were decontaminated to LLW, penetrations and hidden surfaces could not be decontaminated. To minimize the impact on the project schedule, the transuranic glovebox was packaged and sent to the onsite Hanford size-reduction facility at T-Plant. Figure 3 shows the packaged glovebox.

Figure 3. After the internal equipment was removed from the incinerator glovebox, the glovebox was packaged and removed from the facility to be size reduced at the Hanford size-reduction facility at T-Plant.

With the glovebox removed, the team could enter the scrubber cell for the first time in 15 years. Figure 4 shows the team preparing to enter the scrubber cell. The ability to characterize the scrubber cell from the outside was very limited, so substantial controls such as tenting, additional filtered ventilation exhausters, fresh airline 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 hours. The cell was sprayed with a fixative prior to the initial entry and then routinely fogged to ensure surfaces were wetted during future entries.

Figure 4 – Prior to entering the scrubber cell access tent, a final check of PPE is conducted and the fresh air breathing hose is attached. Monitoring of the airborne environment, conducting aggressive ash fixing processes and performing extensive checks on protective equipment resulted in 104 safe entries into the highly contaminated scrubber cell room.

Additionally, the environment inside the scrubber cell and attached tent was monitored every 15 seconds for changes in the levels of airborne contamination. .. These changes were communicated to the workers inside the cell to help them know when additional contamination controls were necessary.

The deactivation team continued to find plutonium fly ash outside the scrubber equipment. Additionally, fly ash was discovered hidden in sections of the filter boxes that were past the roughing filters. Further, the floor drain traps in the scrubber cell had liquids that needed to be pumped out and solidified.

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 LLW.

With the completion of the scrubber cell decontamination, workers could proceed with the removal of the process ventilation system .. The active process ventilation system consisted of a highly contaminated process exhaust system that had its own HEPA filter box. Additionally there was a room-based ventilation system that pulled air through filters located in the process room floor and discharged through the final building HEPA filters. Tenting and glove bags were required to remove and size reduce the process portion of the ventilation system. The room exhaust floor filter could be removed on just filter mask protection.

Open-air modeling had determined that all the HEPA filter media had to be removed during the deactivation effort, though ducts that were LLW could remain if internally fixed. The decontamination effort in the scrubber cell had removed more grams of plutonium than were originally planned, so NDA characterization was used extensively to determine which ducts could be left in the final filter room and not exceed the requirements for open air demolition..

An engineered "free-flowing" grout was poured into the inactive portion of the underground ventilation system to structurally and radiologically stabilize that portion of duct. The building was then sprayed with fixative to bond the remaining contamination to hard unyielding surfaces to minimize dispersion during demolition.

Several general building activities that had to be completed during deactivation to prepare for open air demolition:

- Remove asbestos insulation on piping
- Remove batteries, hydraulic oils, capacitors, mercury lights and light ballasts
- Drain refrigerant and chemicals from piping
- Isolate the building fire detection and suppression systems
- Isolate electrically energized systems such as power, communications systems, criticality alarm system
- Isolate support systems including vacuum for radiation monitors and water

The deactivation of the 232-Z facility was completed on June 1, 2006. At that point the facility was transferred to a demolition team that had been planning and training for the very different task of demolishing the building with large equipment. This approach allowed the two teams to specialize and properly prepare for the very divergent work scope while allowing the project to complete the demolition of the building nine weeks ahead of the HFFACO milestone.

CONCLUSIONS

The success of the 232-Z facility decontamination and deactivation project was based on many factors. The commitment of all the parties; DOE-RL, WDOE and EPA, to see the job completed was most important. The swift response of the regulators under CERCLA and the innovations of a Documented Safety Analysis (DSA) that covered the full life cycle of the project are examples of an effort where all the stakeholders are committed to a common goal.

Other factors in the project’s success include:

- The continuous use of NDA to support planning and decisions in the field

- Team members, that would be doing the work in the building, leading the planning for each task on the project (this lead to field innovations and a true commitment of the team)

- The flexibility of the team and the regulators to respond to the continually changing conditions in the field as plutonium contamination was located in unexpected places

- The use of sophisticated air modeling and demolition planning to establish a clear transition point between deactivation and demolition

- The continual use of innovation with examples such as the continuous monitoring of airborne release in the scrubber cell, the use of engineered “free-flowing” grout for the underground ducts, and the innovative feed back approaches for controlling plutonium in the scrubber cell, and

- The development of a DSA that covered the full life cycle of the project allowing for deactivation work to be completed and then for the flexibility to eliminate inapplicable controls for the demolition phase.

REFERENCES

1.] *Engineering Evaluation/Cost Analysis for the Removal of the Contaminated Waste Recovery Process Facility Building 232-Z* (DOE/RL-2003-29)
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3] *Hanford Federal Facility Agreement and Consent Order* (HFFACO), Ecology et.al, 1989
4.] Hopkins, A., et al, *Deactivation and Decommissioning Environmental Strategy for the Plutonium Finishing Plant Complex, Hanford Nuclear Reservation, 2003*
2003
5.] *Removal Action Work Plan (RAWP) for the 232-Z Contaminated Waste Recovery Facility* (DOE/RL-2004-61)
6.] *Plutonium Finishing Plant (PFP) Complex End Point Criteria* (HNF-22401)
7.] *232-Z Site Specific Health and Safety Plan* (HNF-20848)
8.] *232-Z Contaminated Waste Recovery Process Facility Waste Management Plan* (HNF-20862)
9.] *232-Z Contaminated Waste Recovery Process Facility Demolition Plan* (HNF-20890).
10.] *232-Z Building Final Slab-on-Grade Characterization Report* (M2300-06-010)