Progression of Safe and Compliant Demolition of Hanford's Plutonium Finishing Plant (16566)

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ABSTRACT

Department of Energy contractor CH2M HILL Plateau Remediation Company (CH2M) is about to begin demolition of the Plutonium Finishing Plant (PFP). The facility is located on the Hanford Site and produced plutonium metal during the Cold War. Production was stopped in 1988, the facility was formally shut-down in 1996 and material processing completed in 2004. The project team, partnering with DOE-Richland Operations Office (DOE-RL), is in the final stages of preparing to demolish the building by the Tri-Party Agreement Milestone date of September 30, 2016.

Since 2008, employees have prepared approximately 85 percent of the building for demolition. All of the 52 pencil-shaped processing tanks and 95 percent of the 238 glove boxes have been removed. Work is progressing on dispositioning remaining glove boxes, filter boxes and ventilation ducts and chemical and drain lines. Demolition is scheduled to start in early 2016. In addition to wrapping up tasks like source term removal (or preparation for removal during pre-demolition) and decontamination, the project is also developing the strategy and process to perform physical open air demolition, including the use of 3D renderings and computer generated illustrations of building infrastructure to safely and compliantly demolish the building.

INTRODUCTION

PFP, also known as Z-Plant, operated from 1949 to 1989 and represented the final step in the plutonium production effort at Hanford. At this facility, plutonium was processed into solid, hockey-puck sized "buttons" and plutonium oxide powder that could then be safely shipped to the country's weapons production facilities. PFP produced nearly two-thirds of the nation's plutonium stockpile.

By December of 2009, containerized plutonium-bearing material stored at PFP was successfully stabilized, packaged, and shipped to the Department of Energy's Savannah River Site and to another Hanford on-site location. Ancillary building demolition began in 2012 with the removal of vaults that once held plutonium. By November 2015, work inside the building progressed to potentially the most hazardous work ever undertaken at PFP, including:

- Size reducing two large, high holdup glove boxes. Contamination levels during size reduction activities require workers to wear pressurized suits and breathe supplied air.
- Preparing to remove chemical tanks from 242-Z, a building left severely contaminated as a result of a 1976 explosion inside a glove box
- Cleaning off the Plutonium Reclamation Facility canyon floor and decontaminating the canyon, left contaminated after years of chemical leaks and spills.

Highly trained, skilled and dedicated PFP employees are expected to wrap up these three jobs by early 2016, allowing crews to then focus on the critical path project:

removing (or preparing to remove during demolition) the nearly 9,000-feet of contaminated ventilation ducting. Through November 2015, workers have dispositioned more than half of the duct work.

Demolition is scheduled to start in March 2016 and steadily progress throughout the spring and summer, with target completion by September 30, 2016.

The safe, compliant demolition of PFP is necessary to protect human health and the environment, as well as reduce lifecycle costs for the Hanford Site.

DEMOLITION PHASES STRATEGY FOR HAZ CAT II FACILITY

The principle Plutonium Finishing Plant (PFP) structure, Building 234-5Z, was built in the late 1940's and began operation in 1949. Building 291-Z, which houses ventilation exhaust fans and mechanical service equipment, were constructed at the same time as 234-5Z. The initial mission of the PFP facilities was to process weapons-grade plutonium for nuclear weapons. In the original design of PFP, all of the planned operations and laboratories, except waste collection and disposal, were provided in 234-5Z. With increases in production, storage, and scrap recovery requirements, the following major additions were made:

- The 236-Z Plutonium Reclamation Facility (PRF)
- The 242-Z Waste Treatment Facility
- The 232-Z Waste Incinerator Facility (demolished in 2006)
- The 2736-Z Support and Storage Complex (demolished in 2012)

Aerial photo of the PFP Complex.

Deactivation, decommissioning and demolition of 234-5Z, 242-Z, 236-Z, 291-Z, and the support facilities involves the removal of radioactively contaminated equipment, piping, and glove boxes from the facilities and packaging these items into waste containers. Radioactive material is present in significant quantities as holdup in the glove boxes, ventilation ducts, and other equipment to be removed, including abandoned vacuum piping in 291-Z; and will be contained in the waste containers generated during waste removal. Contamination is also found throughout the buildings being deactivated and decommissioned.

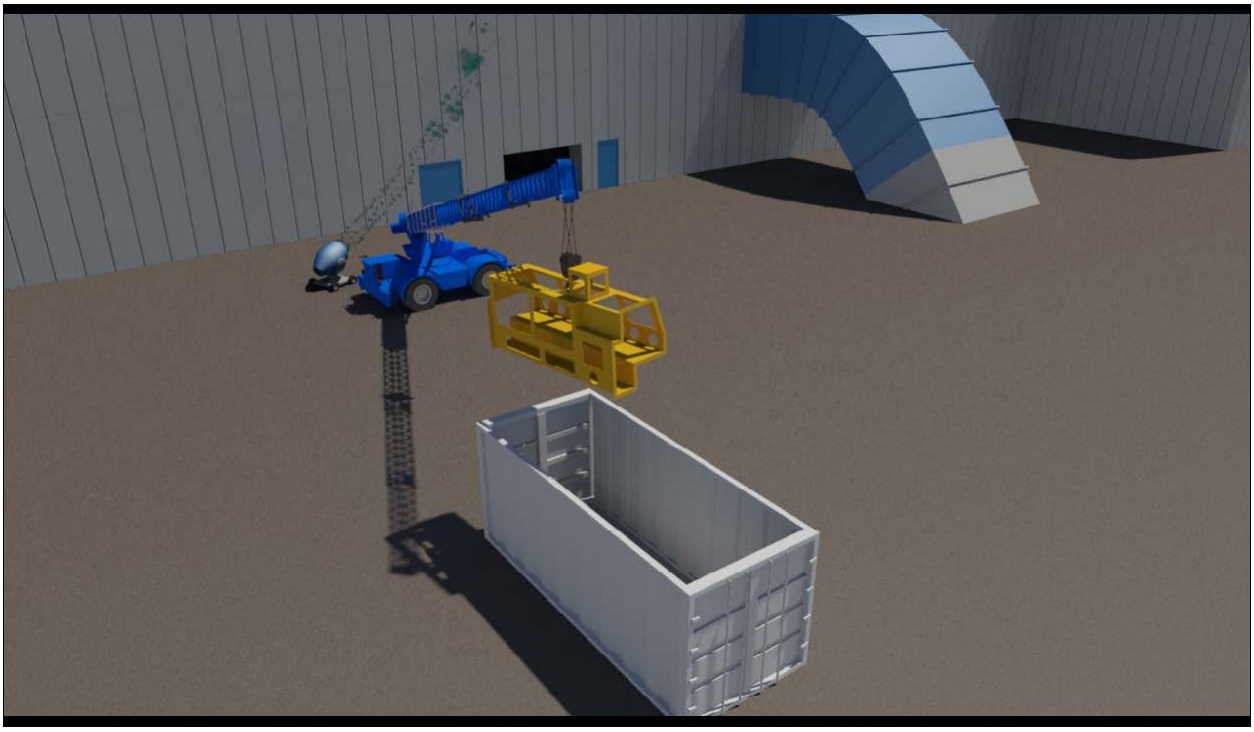
The PFP Complex facilities are collectively categorized as a Hazard Category II, non-reactor nuclear facility and consist of four primary buildings, 234-5Z, 242-Z, 236-Z, and 291-Z. Although the inventory of two of these buildings will be at a Hazard Category III level during demolition, the DSA does not segment them as separate facilities. The demolition strategy for the Complex is to dissect the buildings as a consecutive series of Haz Cat III containing sections.

To support this, demolition is planned according to three remaining major activity phases. Each activity phase represents a scope of activities that will be performed, including the configuration of any material-at-risk in the facility, and will be used to develop boundaries for hazard and accident analyses.

Phase 1: Deactivation – this phase encompasses currently ongoing activities for glove box/equipment decontamination, disassembly and waste removal. These activities represent the effort to remove radiological material-at-risk. All buildings will have controls restricting personnel access prior to the start of demolition. As part of the preparation for demolition, bulk area cleanout will be conducted to remove filters, drain chemical headers, and prohibited articles, and to provide asbestos abatement, as needed. Drain lines and process piping that go through the slab will be isolated and plugged. Mechanical equipment, electrical equipment, and utilities in 234-5Z, 236-Z, 242-Z, 291-Z, and 291-Z stacks will be isolated and air-gapped for hazardous energy control prior to initiation of demolition activities for that facility. The facility will then be considered cold and dark.

Energy may remain for one building while demolition is proceeding on another building (e.g., energy may remain for 234-5Z while demolitions is proceeding on 236-Z). Temporary power will be used, as needed. Following completion of pre-demolition activities, a walk down will be conducted to verify that the structures are ready for demolition.

Phase 2: Pre-Demolition – this phase of activities involves the removal of glove boxes and other transuranic (TRU) waste items that will remain in the facilities after Deactivation. The items to be removed will be accessed by breaching an outer boundary wall to allow their removal in a controlled manner, so as to minimize the accident potential. Removal of these items will be by excavator, forklift or other fuel powered vehicle. Placement into waste containers will be by crane (top loading waste container) or forklift (side loading waste container).



Computer model of glove box removal from 234-5Z during pre-demolition.

Other Pre-Demolition phase activities include grouting TRU piping in the 234-5Z tunnels and trenches, grouting the 236-Z canyon floor, removal of hazardous waste, and removal of all energy sources so that the facilities may be declared Cold and Dark. In this phase portions of the fire protection and ventilation system will be deactivated and removed.

Phase 3: Demolition – this phase of activities involves the demolition of the 234-5Z, 242-Z, and 236-Z above grade structures and support facilities. Some TRU waste items that were isolated and prepared for loading into waste containers as part of the Pre-Demolition activities will be removed during the Demolition phase. These items will require the demolition of exterior walls, interior walls/partitions or floors for access. Demolition activities also involve the removal of accessible TRU waste below grade such as the drain piping in the 234-5Z tunnels and the 232-Z ventilation duct.

DEMOLITION OF 236-Z

236-Z has four stories plus a two-story column penthouse. The penthouse encloses the upper portion of the column glove box. Except for the roof and the south end of the canyon, the building is constructed of reinforced concrete.

The main structural building system is composed of a bearing wall system in which the interior and exterior supporting walls are used to resist both vertical and horizontal loadings. The floor and lightweight concrete roof system comprise a rigid diaphragm floor system that transfers lateral loads from each level to the supporting shear walls and base level foundation system.

This building, and its construction type, is robust in nature and well suited for select demolition on a level-by-level, zone-by-zone basis. In this approach, the structure can be removed by level, on a bay-by-bay sequence in which portions of the walls and floor systems can be removed with little or no effect on the remaining structural system. This approach maintains structural stability of the remaining building system throughout the demolition process.

Overall, demolition will begin on the sixth floor by opening an access hole to remove the staged column and column hood glove boxes, followed by completely removing the sixth floor structure. A similar process will be followed for the fifth floor.

Computer model of surgical removal of column glove box on the 6th floor of PRF.

On the fourth floor, miscellaneous treatment glove boxes will be removed, followed by demolition of the chemical preparation and control room areas. Proceeding to the third floor, second floor, and first floor requires awareness of the canyon structure. The canyon structure will be the final section of 236-Z to be demolished. The third floor will be removed by progressing from the exterior wall to the canyon wall. The second floor will be removed similarly from the exterior wall to the canyon wall. The second floor demolition will require the removal of the gallery glove boxes. The gallery glove boxes on the east and west canyon walls will be removed in sections (staged during pre-demolition with application of fixative and stitch cut

into appropriate size for shipment, based on plutonium gram quantity and physical size for waste containers). Ventilation filter boxes and Filter Bank A/B/C/D exhaust filter boxes will be extracted from the second floor. The first floor will be demolished in a similar manner as the second floor. The canyon will be the final section of the facility to be demolished due to the thickness of the wall and the staging of the canyon strong-backs. An access point will be created to remove the canyon strong-backs while the floor plans will remain as a component of the slab, which enables the complete demolition of the canyon to slab on grade.

DEMOLITION OF 242-Z

242-Z consists of two rooms and an airlock of shorter height at the west end. The building is located between the southeast corner of Building 234-5Z and the north wall of 236-Z. Corridor 242-B runs along its eastern edge while connecting Buildings 234-5Z and 236-Z.

The south wall of Building 242-Z (common with 236-Z) is constructed of reinforced concrete. The remainder of the building has a structural steel frame covered inside with metal lath and plaster, and outside with insulating-material wall panels. The slightly peaked roof is constructed of metal decking covered by insulation and built-up asphalt and gravel.

Following demolition of 236-Z, access for tank removal from 242-Z is possible. The strategy for demolishing 242-Z is to progress through the facility starting with the Tank Room. Within the Tank Room, each tank will be staged during pre-demolition and extracted from the building during the demolition phase. Following removal of the tanks, the remaining structure, including 242-ZA and the airlock, will be demolished down to the slab. As demolition activities proceed through the facility, nine tanks will be extracted and placed in waste containers for transport to an off-site processing facility.

DEMOLITION OF 243-5Z

The facility will be demolished in sections that include the full height of the facility. As the demolition activities proceed through the facility, eight glove boxes, a pencil tank assembly, ventilation ductwork and selected filter boxes will be removed and placed in the appropriate waste container. All objects have been decontaminated to the extent possible, with fixative applied, rigging installed and will have protective scaffolding around them to protect them during demolition work.

Overall, demolition will begin on the northeast end of 234-5Z with the area of least contamination. The northeast end of the facility includes 234-5ZA, followed by the front side that runs the length of the facility from east to west. The A-Labs area will be an area within 234-5Z with higher residual contamination fixed in place and will include demolition of a portion of the duct level. Staged glove boxes, filter boxes, piping, and ducting will be extracted from the main floor and the duct level.

As compared to the Annex and front side, A-Labs and the remainder of the facility will proceed at a noticeably reduced rate due to the residual contamination levels, the need to extract staged equipment and the demolition of multiple floors within

each section of the facility. Upon completion of A-Labs, demolition activities will proceed to Backside Rooms/PPSL and run the length of the remaining facility from east to west. C-Line and A-Line will come next, with RADTU being the last area. RADTU will be the final area to be demolished because it will provide an access point(s) into the basement of 234-5Z to enable the removal of the process drain lines. Following the removal of the process drain lines, the basement will be filled with clean backfill material from an onsite barrow pit.

DEMOLITION OF 291-Z EXHAUST FAN, COMPRESSOR HOUSE AND STACK

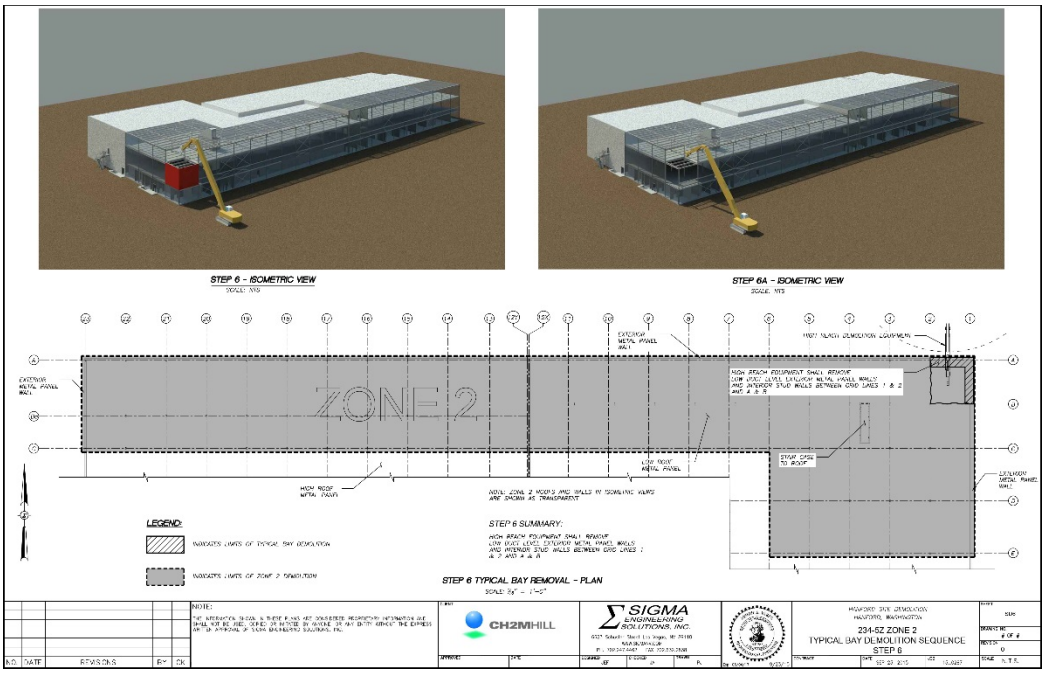
After the exhaust system for intrusive deactivation activities in 234-5Z, 242-Z, and 236-Z is no longer needed and TRU contaminated items, waste packages, and loose items within 291-Z have been removed, filtered exhaust through the 291-Z-1 stack will be sealed and isolated. Contaminated piping entering or exiting 291-Z will be flushed, sealed at entry and exit points, and identified and labeled. Below grade excess, unattached, and/or loose items will be removed prior to filling below grade spaces. The wall sections above grade will be leveled into 291-Z, then 291-Z will be filled with clean backfill material from an onsite barrow pit.

Demolition of the 291-Z stack will be completed in two phases. First, explosive demolitions will be completed to bring the stack to the ground, followed by traditional downsizing of concrete and loading into waste containers. Explosive demolition will only be performed on the 291-Z stack. The explosive demolition will be planned and performed by a subcontractor with proven experience and expertise while following the applicable operating policies and procedures.

STRUCTURAL ENGINEERING ANALYSIS TO GUIDE DEMOLITION

CH2M has conducted a thorough structural evaluation of the buildings within the PFP complex. Consideration of the structural design of the buildings will guide demolition activities, with demolition occurring in a methodical, sequenced progression to ensure structural stability of the building as demolition progresses.

Specifically, the main structure of PFP, 234-5Z, consists of a 440 foot long structure running in an east to west direction. The length of the structure is composed of 22 equal length bays of 20 feet each. The original building structure is composed of three floor levels and a roof level. The main structural system consists of a combined shear wall and steel frame building system, which provides vertical and lateral support of the wall, floor, and roof systems. Demolition of the 234-5Z Building will be achieved with high-reach type demolition equipment on a bay-by-bay, zone-by-zone basis. This approach allows the structure to be removed in mass segment while maintaining the structural integrity of the remaining building segments.



Example of structural engineering drawings that will be used to guide demolition activities.

OTHER CONSIDERATIONS

This paper provides an overview of the demolition sequence and process and does not include important other elements CH2M is incorporating into its demolition plan, including:

Safety Basis: CH2M will update the safety basis documents to ensure they reflect changes in the facility, the work and the hazards as they analyzed in the documented safety analysis. The information will be used by DSA/TSR developers to establish boundaries for the analysis and to develop appropriate controls for the hazards during each of the phases. Each phase of activities represents a different scope of work under different facility configurations and will be analyzed separately.

Health and Safety Plan: CH2M is updating PFP's Health and Safety Plan (HASP) to address the health and safety requirements for deactivation activities and will include activities associated with demolition of buildings within the PFP Complex. Response to upset conditions and emergency response reactions will be within the HASP. As part of demolition preparation, an emergency response program will be developed and a drill conducted to demonstrate the response to upset conditions and response readiness of personnel and equipment.

Facility Characterization: A thorough characterization effort is underway at PFP to provide data for air dispersion modeling of radioactive releases during demolition. Air dispersion modeling will provide feedback on the amount of decontamination or stabilization necessary to limit the airborne concentration

outside of a posted airborne radioactivity area to less than 20 percent of a derived air concentration (DAC).

Characterization will also support decision making prior to demolition, like whether to remove an item from the facility prior to demolition, surgically remove during demolition or keep the item in place during demolition.

Air Dispersion Modeling: Pacific Northwest National Laboratory will perform and provide results from dispersion modeling for demolition. The model will use modeling codes, such as U.S. Environmental Protection Agency approved American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) with open-air demolition methodologies, and will account for demolition emissions controls to be used at the facility. Based on this dispersion modeling analysis, a formal report will be prepared to determine potential contamination deposition and document airborne monitoring considerations. The dispersion model will include anticipated atmosphere conditions; demolition methods; airborne dispersion mitigation methods; source term conditions; boundary distances; and reduction factors of planned contamination controls, such as fixatives, and water suppression.

The dispersion model will identify realistic combinations to provide a 0.2 DAC boundary. The model will compute atmospheric concentrations and resulting deposition patterns (accounting for dispersion and deposition, for example) in both the immediate and surrounding area of the buildings. The model will provide contamination disposition evaluations based upon a radiological boundary (200 ft). The modeling will establish source term and form for selected demolition of the major structures, identifying assumed mitigation methods for each, and provide plots of computed airborne contamination concentrations and contamination deposition as a function of distance from the demolition site for various anticipated seasonal atmospheric conditions.

Airborne modeling within the report will estimate expected concentration levels at existing near facility monitors and evaluate the requirements for additional facility specific sampler locations both inside and outside the perimeter fence.

Criticality Controls: Nuclear criticality safety criteria for fissile material will be determined to ensure that criticality is incredible during demolition and disposal of the PFP Complex. Nuclear criticality safety limits, which consist of both mass and concentration limits, have been developed to ensure that waste packages and PFP Complex debris remain subcritical.

Waste Management and Handling Plan: Based on the characterization, quantities of low-level waste (LLW), transuranic (TRU) waste, polychlorinated biphenyls-bulk product waste, and asbestos containing materials may be generated. The waste management and handling practices will be performed in accordance with federal and state requirements. Waste is characterized and containerized to meet waste acceptance criteria. The waste acceptance criteria limit for shipment is 325 g of plutonium in an SLB2 or SWB. The acceptance criterion is

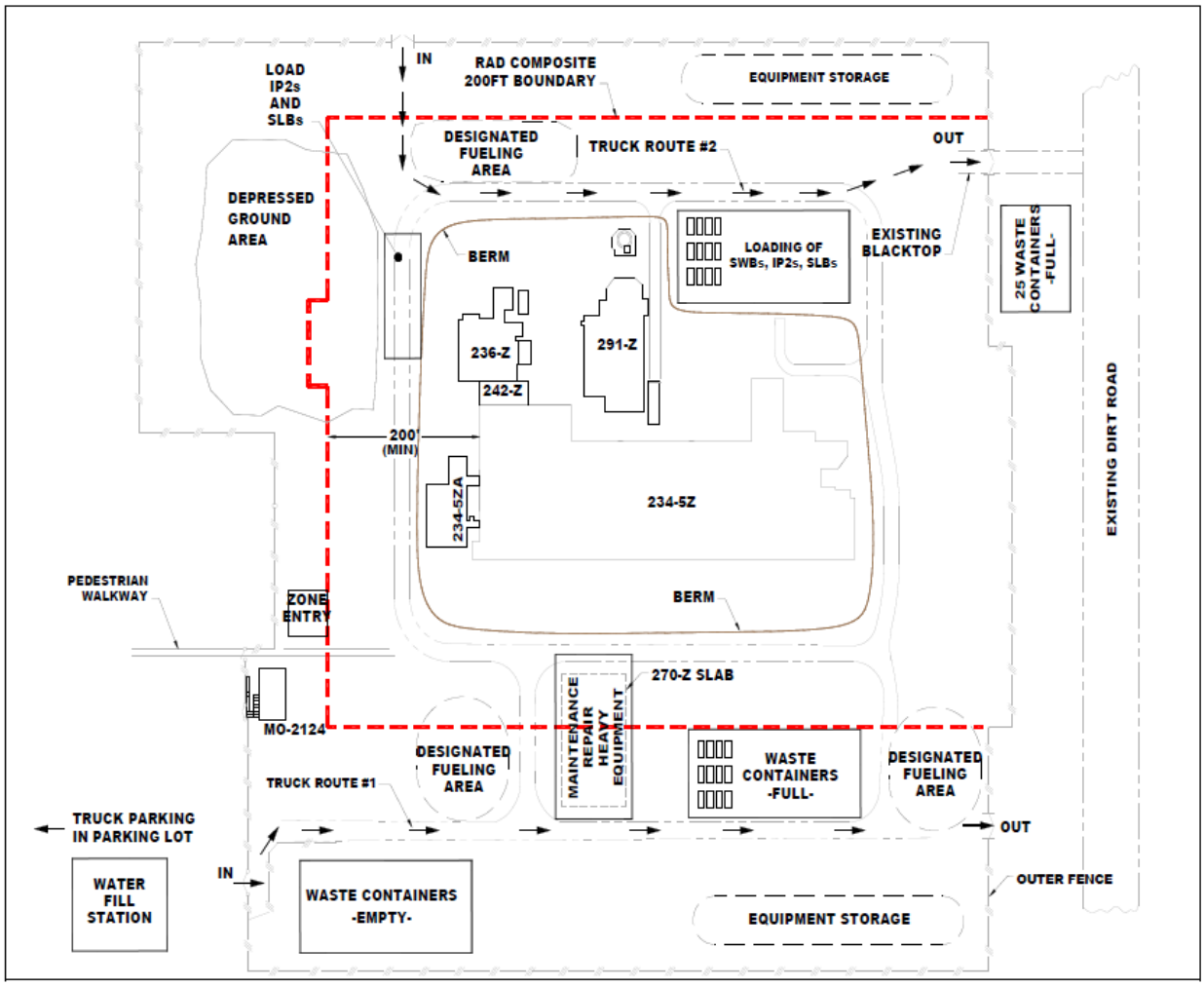
200 g of plutonium for drums and items designated for Perma-Fix (off-site waste processing facility).

Separate from the work authorizing documents, multiple Environmental Restoration Disposal Facility (ERDF) waste profiles have been generated for disposition of waste from the PFP Complex that has been determined to be acceptable for ERDF disposal.

Some waste items known to be left in the structure and segregated during demolition are marked to identify them more readily during demolition. Identification of such items that could not be effectively removed prior to demolition could include marking select process piping and components in orange paint.

Any wastes unexpectedly found to exceed radiological requirements for ERDF waste profiles may be processed within a temporary containment. The temporary containment will provide environmental protection and contamination control, should processing of the waste or material need to proceed to meet ERDF radiological criteria.

Site and Traffic Control Plan: Prior to demolition, preparations will be completed to facilitate movement of waste and equipment, as well as control the entry and exit locations for project personnel. A demolition zone access boundary fence, ERDF roll-on and roll-off holding areas, TRU container storage areas, contaminated heavy equipment maintenance area, and equipment storage areas will be constructed, as shown below.



Site diagram for demolition activities.

SUMMARY

The work to prepare PFP for demolition involves some of the most hazardous work ever performed within the DOE complex. That work will continue into 2016, as certain aspects of plans to demolish PFP are finalized to ensure the safe and compliant demolition of a hazard on the Hanford Site.

By March 2016, demolition should be underway or about to begin at PFP, allowing Waste Management Conference attendees to receive the current status of demolition efforts at PFP.