**Project Name:** ID-PBF-620 Power Burst Reactor-D&D

**Project Name (Expanded):** Idaho ID-PBF-620 Power Burst Reactor D&D [Deactivation and entombment of an 19,000 SF test reactor, including component removal, pressure vessel removal preparation, demolition of above-ground steel-frame and portions of below-ground concrete structures, removal and disposal of the pressure vessel, and backfill/grouting of all below grade voids]

**Project Type:** Building / Facility D&D Project Type

**FIMS Hazardous Category:** 04 Radiological Facility (previous Building Type 2)

**Project Type Detail:** Reactor - Test/Small Experimental

**Supplementary Reference Documents**
- Removal Action Report for the Idaho Cleanup Project Power Burst Facility and Waste Experimental Reduction Facility, August 2011
- Action Memorandum for Power Burst Facility (PER-620) Final End State and PBF Vessel Disposal, July, 2007

**Site Context:**
The Idaho National Energy and Environmental Laboratory (INEEL) site is in a 890-square mile reservation in southeast Idaho, with significant extremes of weather. The initial INEEL mission as the development and testing of nuclear reactors, first for the US Navy and then for a variety of other programs. Facilities also supported the reactor training for Navy personnel and the processing of military reactors cores to recover the uranium (the naval training is not part of the DOE mission). It also includes numerous laboratories and legacy waste in burial grounds and various other storage configurations. The current mission is science research, mostly in advanced reactor development, environmental cleanup, support operations, and waste management. Contaminants include fission products in dispersed and concentrated forms, and transuranic constituents. In particular, significant quantities of buried TRU waste required repacking prior to disposal at WIPP.

**ECAS Level 4/Parent Project Context:**
The Parent Project grouping developed for this ECAS Project is based on actual cost data for the Idaho Cleanup Project over the period of 2005 to 2016. This period included numerous projects and operations, including D&D projects, environmental restoration projects, waste management projects and operations, and numerous other site operations, activities, and overhead functions. It also included shifts in WBS structure. The five projects chosen as part of this effort were completed D&D projects that would best address deficiencies in the ECAS database.

The selected ECAS Projects are all are part of independent D&D efforts (i.e., not comingled with extensive operations or waste activities), but some falling within different Level 2 site WBS elements. The projects are given below, with the Level 2 WBS elements given in parentheses:

- ID-TRA-642 Engineering Test Reactor-D&D (P.3.D2, TRA/PBF D&D)
- ID-PBF-620 Power Burst Reactor-D&D (P.3.D2, TRA/PBF D&D)
- ID-TAN-607 Hot Shop/Manufacturing & Assembly-D&D (P.3.D1, TRN D&D)
- ID-TRA-603 Material Test Reactor-D&D (P.3.D2, TRA/PBF D&D)
- ID-TRA-632 Hot Cell Building-D&D (T.7.03, TRA/PBF D&D)
D&D Facility Data:
Facilities (FIMS data where possible):

<table>
<thead>
<tr>
<th>Building (Property ID)</th>
<th>Title (Property Name)</th>
<th>Area (SF)</th>
<th>Year Built</th>
<th>Contamination Category</th>
<th>Hazard Category 1</th>
<th># of Floors</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBF-620</td>
<td>Reactor Building</td>
<td>18,679</td>
<td>1970</td>
<td>Not Given</td>
<td>04 Radiological Facility</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building (Property ID)</th>
<th>Title (Property Name)</th>
<th>Asset Type</th>
<th>RPV Description</th>
<th>Usage Code</th>
<th>Disposition Date</th>
</tr>
</thead>
</table>

Construction Details:
The PBF is located in the south-central portion of the INL in the former Waste Experimental Reduction Facility/Waste Reduction Operations Complex/Power Burst Facility area, approximately 14.5 km (9 mi) east of the Central Facilities Area.

PBF consisted of the main floor, which sat at approximately ground level; the first basement, which extended to approximately 20 ft below ground level; and the second basement, which extended approximately 40 ft below ground level. The loop cubicles were located on the north side of the first basement. There were two cubicles with a sample room between them. The main function of this chamber was to process the experimental loop coolant. Behind Cubicle 10 was the sampling room; easternmost, behind the sampling room, was Cubicle 13, which housed the blowdown tank, the fission product detector system, and other functions. The second basement contained the subpile room, waste gas room, knockout drum room, and warm waste sump room.

Cutaway rendering of the Power Burst Facility (PER-620) looking east

The PBF reactor building housed the reactor vessel, fuel storage canal, and various process systems that supported reactor operations. The structure was a two-story, steel-frame building with steel plate interior with aluminum exterior siding and two block-wall wings (east and west). The building was divided into a main reactor high-bay room, two single-story wings containing instrumentation and electrical control equipment, various support offices, operational and utility areas, and a two-level basement.
The PBF vessel is constructed entirely of Type 304 stainless steel. The overall vessel length is approximately 30 ft and the vessel is approximately 15 ft in diameter with a ½-in.-thick wall. The vessel is supported by a “skirt” that increases the diameter of the vessel to nearly 18 ft. The approximate total weight of the vessel and internals is 113,300 lb (56.7 tons).

The internals of the vessel include transient and control rod assemblies (rods and guide tubes), core support grid, flow skirt, core side plates, and support structures. Two nozzles, protruding from the bottom of the vessel, provided the primary coolant inflow and outflow. A rectangular opening in the south side of the vessel connects with the PBF storage canal. Fuel rods, the in-pile tube, and other components were transferred underwater between the vessel and the canal through this vessel opening. A reinforced carbon steel cover was installed on the top vessel opening in 2005.

The vessel contains no hazardous waste, beryllium, asbestos, or polychlorinated biphenyls (PCBs). The vessel internals are constructed of stainless steel, aluminum, and B4C. The vessel and canal were drained of primary coolant water in 2005.
Power Burst Facility Vessel installation 1970.

Cutaway rendering of the PBF vessel (in-pile tube dispositioned to ICDF).
Power Burst Facility Cubicle 10 before removal.

Power Burst Facility Cubicle 13 before hot spot removal.
Power Burst Facility demolition.

Power Burst Facility vessel removal.
Power Burst Facility vessel move to the Idaho CERCLA Disposal Facility.

Facility Use:
Construction on PBF began in 1966 and was completed in 1971. It was operated from September 22, 1972, until February 7, 1985. PBF was designed and built to perform experiments on nuclear fuel. Samples were exposed to transient and steady-state neutron fluxes to test fuel behavior under controlled accident conditions. Experiments were contained in an Inconel 718 in-pile tube that occupied the central flux trap of the core and extended well above and below the core. The testing environment for the in-pile tube was provided by the pressurized water coolant loop.

Unlike other test reactors that used beryllium to reflect neutrons, the PBF fuel rods were surrounded by a row of solid stainless-steel reflector rods. There were eight boron carbide (BC) control rods and four transient rods of similar construction used to control criticality and flux transients. The PBF fuel rods were removed from the facility in summer 2003 and placed in dry storage at the Idaho Nuclear Technology and Engineering Center. The in-pile tube was removed and disposed of at the ICDF in 2005.

The PBF reactor was placed on operational standby in 1985 and the fuel rods were removed in the summer of 2003. Deactivation of the PBF canal began in October 2003. Canal Deactivation Project activities consisted of removing materials and equipment from the fuel storage canal and placing the canal in a stable, low-risk condition. Deactivation included the removal of activated fuel canisters, activated stainless-steel shim and reflector rods, aluminum filler rods, fuel rod storage racks, ion and fission chambers, a seismic support system for racks, fixed equipment, a plutonium-beryllium reactor startup source, canal water, corrosion coupons, sediment, and debris. All liquid-bearing systems were
isolated. Divers were placed into the canal to seal weld the canal gate into place to isolate the reactor from the canal. In addition to installing the canal gate, the divers removed and cleaned loose radiological contamination from the walls and floor of the canal and applied a fixative to the canal walls and floors. The water was cleaned by filtering and was pumped out to the PER-706 evaporation tank. Canal Deactivation Project activities were completed in August 2004.

A “Phase 1” Deactivation occurred prior to the work associated with this project. Decommissioning work accomplished during the Phase I NTCRA resulted in the following interim end state for the PBF complex, which consisted of the PER-620 reactor building, out-buildings for storage backup generators and compressed air, and the PER-706 evaporation tank:

- All buildings and structures external to PER-620 were demolished to grade.
- PER-620 was drained of all liquids, including the primary and secondary coolant. The warm waste tank (PER-632) was drained and the liquids were solidified and disposed of at the Radioactive Waste Management Complex. The warm waste tank was also disposed at the Radioactive Waste Management Complex.
- Over 235,000 lb of lead was removed from PER-620 and either recycled or sent off-Site for disposal. Cadmium sheeting was removed from Cubicle 13 and disposed of off-Site.
- The in-pile tube in the PBF vessel was removed and disposed of at the ICDF.
- A carbon steel cover was installed over the PBF vessel.
- All utilities to and from the PER-620 building were isolated, including potable water, fire water, electricity, and sewer.

Phase I was completed at the end of April 2005, with the exception of the demolition of the PER-706 evaporation tank, which was completed in November, 2005.

Processes causing contamination: See above

Contaminants of concern (including extent of contamination by major contaminant):
Direct radiological readings of the PBF vessel were taken in January 2007. The vessel no longer contained primary coolant, so the readings taken were not affected by the shielding effects of water. The highest dose rate on the outside of the vessel was 560 mrem/hour, and the highest measured in the vessel was 1.8 R/hour. Modeling was used to determine the potential maximum dose rate in the vessel core area, and the results indicated 6.4 R/hour. Radiological readings were also taken for the entire building. The estimated radionuclide inventory for PBF in the above-ground-level interval was 5.11 Ci, and the below-ground-level inventory was 43.9 Ci. Therefore, the total source term for PBF, with the 21.8-Ci estimate in the PBF vessel, was approximately 49 Ci. Contamination from cesium-137 was the primary human health risk driver.

<table>
<thead>
<tr>
<th>Building</th>
<th>Chemical Hazard</th>
<th>Location/Extent</th>
<th>Radiological Hazard</th>
<th>Location/Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>General buildings</td>
<td>Asbestos, and incidental RCRA constituents; lead, cadmium, mercury; acids and corrosives; mostly removed during Phase 1.</td>
<td>ACM Category I, and Category II materials, various materials</td>
<td>Various radionuclides, including fission products up to High Rad and High Contamination areas</td>
<td>Radiological survey results ranged from background in administrative areas to contamination areas, high contamination areas, radiation areas, and high radiation areas. Locations with elevated contamination</td>
</tr>
</tbody>
</table>

D&D Project Execution
Site WBS Organization within the ECAS Project Scope:
Activities preparatory to the final end state and vessel disposal determination began again at PBF in October 2006. All support buildings and other structures had been removed prior to initiation of the
final end state decommissioning of PER-620 (Phase 2). Phase I of PBF decommissioning had resulted in PBF being put into a "cold, dark, and dry" configuration. Alternative 3 was the chosen approach for the final end state removal action, as documented in the PBF Action Memorandum. The selected alternative included removal and disposal of the PBF vessel at the ICDF. The reactor building was demolished to below ground level, with some structures and systems left below ground level; these consisted of inert materials, such as piping, tanks, structural metal, and utility systems, abandoned in place that did not present an unacceptable risk to human health, groundwater, or environmental receptors. Residual radioactive materials at PBF remaining after D&D activities were completed were below the RAOs for OU 5-12, and no evidence of releases to the environment outside of the PER-620 basement walls or floor were observed during the D&D activities. Void spaces were backfilled as practicable, including the void left by removal of the PBF vessel. Backfill consisted of inert demolition waste from the above-ground-level structures and clean backfill materials.

The PBF vessel contained both activation products from the neutron fluxes received by vessel components during operation and loose and fixed contamination from fission products released during fuel testing. There was an estimated total of 21.8 Ci associated with the PBF vessel.

The reactor core area was filled with water to reduce dose to the workers during strip-out activities in the reactor annulus. This shielding water reduced the background radiation levels in the first and second basement to a level that allowed for direct measurements of those surfaces. Additionally, the contaminated piping contributing to the high general area dose rates in Cubicle 13 was removed.

Based on the PBF vessel’s radiological source term, the vessel met the ICDF waste acceptance criteria for disposal. Since the ICDF is a U.S. Department of Energy waste disposal facility, Nuclear Regulatory Commission waste classification requirements are not applicable. However, for comparison, the PBF vessel would have been classified as Nuclear Regulatory Commission Class A low-level waste. None of the radiological constituents individually exceeded the Class A threshold values nor did the sum of the ratios of all constituents exceed the threshold. The PBF vessel was not classified as transuranic waste.

Conceptual end state for PBF under Alternative 3.

Methods of execution:

Management: The scope was planned, managed, and executed as a single element. Management included technical and project oversight, planning, project controls, and quality assurance.
**Regulatory:** An EECA and Action Memorandum were prepared to determine the appropriate disposition alternatives.

**Physical Approach:**
- Initial characterization, and planning using detailed work packages
- Removal of process equipment - manually removed process equipment using various contamination containment approaches and using hand-held power-tools.
- Abatement of asbestos from all friable sources
- Conventional demolition and loadout of remaining structure; less-contaminated equipment was size reduced as part of the building
- Post-demolition and removal and separate disposal of reactor at on-site CERCLA facility

**Technologies:** No specific details are known about the technologies other than normal D&D activities.

**Activities self-performed:**
- All management and key technical positions along with a portion of the technical staff
- All of the Site hourly labor doing the physical removal of process equipment
- Decontamination of structural surfaces
- Waste management and disposal
- Used significant professional services contracted (i.e., seconded) labor inter-mixed with prime contractor staff

**Activities subcontracted:**
- Removal of non-process equipment
- Characterization of surfaces prior to demolition, and sample analysis
- Waste treatment of mixed wastes (on-site and off-site)
- Demolition of structures

**Issues that impacted the project:**
- None; no “anomalies” were identified.

**Scope Growth:**
None identified.

**Notes Regarding Use of Data**
- Complete below-grade demolition not included in final scope.
- Use of concrete and debris as backfill for below grade spaces, and leaving decontaminated concrete in place would reduce the generation of what would otherwise be LLW.
- Phase 1 (costs not included in project) may have included some normal D&D scope