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Revision 0

Removal Action Report for the Idaho Cleanup Project Power Burst Facility and Waste Experimental Reduction Facility

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Prepared for the
U.S. Department of Energy
DOE Idaho Operations Office

ABSTRACT

This Removal Action Report describes the actions that were taken under the non-time-critical removal action recommended in the *Action Memorandum for Phase 1 of the Decommissioning for the Power Burst Facility Reactor Building (PER-620)* as evaluated in the *Engineering Evaluation/Cost Analysis for Phase 1 of the Decommissioning for the Power Burst Facility Reactor Building (PER-620)* and *Action Memorandum for Power Burst Facility (PER-620) Final End State and PBF Vessel Disposal* as evaluated in the *Engineering Evaluation/Cost Analysis for the Power Burst Facility (PER-620) Final End State and PBF Vessel Disposal*. The first-phase removal actions consisted of disposing of low-level radioactive liquids that originated from PER-620. Much of the asbestos, lead, cadmium, and polychlorinated-biphenyl-containing fluorescent light ballasts were also removed and disposed of. In the second phase of decommissioning, the Power Burst Facility reactor vessel was removed and the reactor building was demolished to below ground level. The removal action also consisted of removing and disposing of remaining asbestos, lead, cadmium, and low-level radioactive liquids and ensuring that materials left in place met the remedial action objectives. The basements and excavated areas were then backfilled with soil, gravel, and demolition debris, and the area was graded and revegetated.

This Removal Action Report also describes the actions that were taken at the Waste Experimental Reduction Facility (PER-609), along with the exhaust stack (PER-756), and the spray dryer absorber (PER-761) under the non-time-critical removal action recommended in the *Action Memorandum for General Decommissioning Activities under the Idaho Cleanup Project,* Revision 1, as evaluated in the *Engineering Evaluation/Cost Analysis for General Decommissioning Activities under the Idaho Cleanup Project*. Lead, cadmium, and polychlorinated-biphenyl-containing capacitors were removed and disposed of. The abovegrade portions of the PER-609 building, along with the PER-756 exhaust stack and the PER-761 spray dryer absorber, were demolished, and the PER-609 basement was backfilled with gravel to grade.

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	curies
COCs	contaminants of concern
D&D	decommissioning and demolition
DEQ	Idaho Department of Environmental Quality
DOE-ID	U.S. Department of Energy Idaho Operations Office
EE/CA	engineering evaluation/cost analysis
EPA	Environmental Protection Agency
HI	hazard index
HWMA	Hazardous Waste Management Act
ICDF	Idaho CERCLA Disposal Facility
ICDWL	INTEC CERCLA Demolition Waste Landfill
INL	Idaho National Laboratory
NTCRA	non-time-critical removal action
OU	operable unit
PBF	Power Burst Facility
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SPERT	Special Power Excursion Reactor Test
WERF	Waste Experimental Reduction Facility

Removal Action Report for the Idaho Cleanup Project Power Burst Facility and Waste Experimental Reduction Facility

1. INTRODUCTION

1.1 Purpose and Objective

This Removal Action Report describes the actions that were taken under the non-time-critical removal actions (NTCRAs) recommended in the following documents:

- *Action Memorandum for Phase 1 of the Decommissioning for the Power Burst Facility Reactor Building (PER-620)* (DOE-NE-ID 2005) as evaluated in the *Engineering Evaluation/Cost Analysis for Phase 1 of the Decommissioning for the Power Burst Facility Reactor Building (PER-620)* (DOE-NE-ID 2004)
- *Action Memorandum for Power Burst Facility (PER-620) Final End State and PBF Vessel Disposal* (DOE-ID 2007a) as evaluated in the *Engineering Evaluation/Cost Analysis for Power Burst Facility (PER-620) Final End State and PBF Vessel Disposal* (DOE-ID 2007b)
- *Action Memorandum for General Decommissioning Activities under the Idaho Cleanup Project* (DOE-ID 2009) as evaluated in the *Engineering Evaluation/Cost Analysis for General Decommissioning Activities under the Idaho Cleanup Project* (DOE-ID 2006a), specifically, the Power Burst Facility (PBF) (PER-620), Waste Experimental Reduction Facility (WERF) (PER-609) exhaust stack (PER-756), and spray dryer absorber (PER-761) (see Figures 1 and 2).

This report demonstrates that actions taken met, and were consistent with, the remedial action objectives (RAOs) of the *Record of Decision Power Burst Facility and Auxiliary Reactor Area Operable Unit 5-12* (DOE-ID 2000) and support the overall remediation goals established through the Federal Facility Agreement and Consent Order (DOE-ID 1991). Waste Area Group 5 consists of PBF and the Auxiliary Reactor Area.

1.2 Scope

The scope of the removal actions for PER-620 included achieving the end state defined in the *Action Memorandum for Power Burst Facility (PER-620) Final End State and PBF Vessel Disposal* and disposal of the PBF vessel at the Idaho CERCLA Disposal Facility (ICDF). The engineering evaluation/cost analysis (EE/CA) was prepared to assist the U.S. Department of Energy Idaho Operations Office (DOE-ID) in identifying the most effective method for decommissioning the structures that had completed their missions. PER-620 and the PBF vessel area were located in the former WERF/Waste Reduction Operations Complex/PBF area within the Idaho National Laboratory (INL) Site (see Figure 1). The NTCRA approach satisfied environmental review requirements and provided for stakeholder involvement, while providing a framework for selecting the decommissioning end states. The NTCRA approach also established an Administrative Record for documentation of the implemented actions.

The scope of the removal actions for WERF (PER-609), the exhaust stack (PER-756), and the spray dryer absorber (PER-761) (see Figure 2) included achieving the end state defined in the *Action Memorandum for General Decommissioning Activities under the Idaho Cleanup Project* and disposal of the structures in the INTEC CERCLA Demolition Waste Landfill (ICDWL). The EE/CA was prepared to assist DOE-ID in identifying the most effective method for decommissioning the structures that had

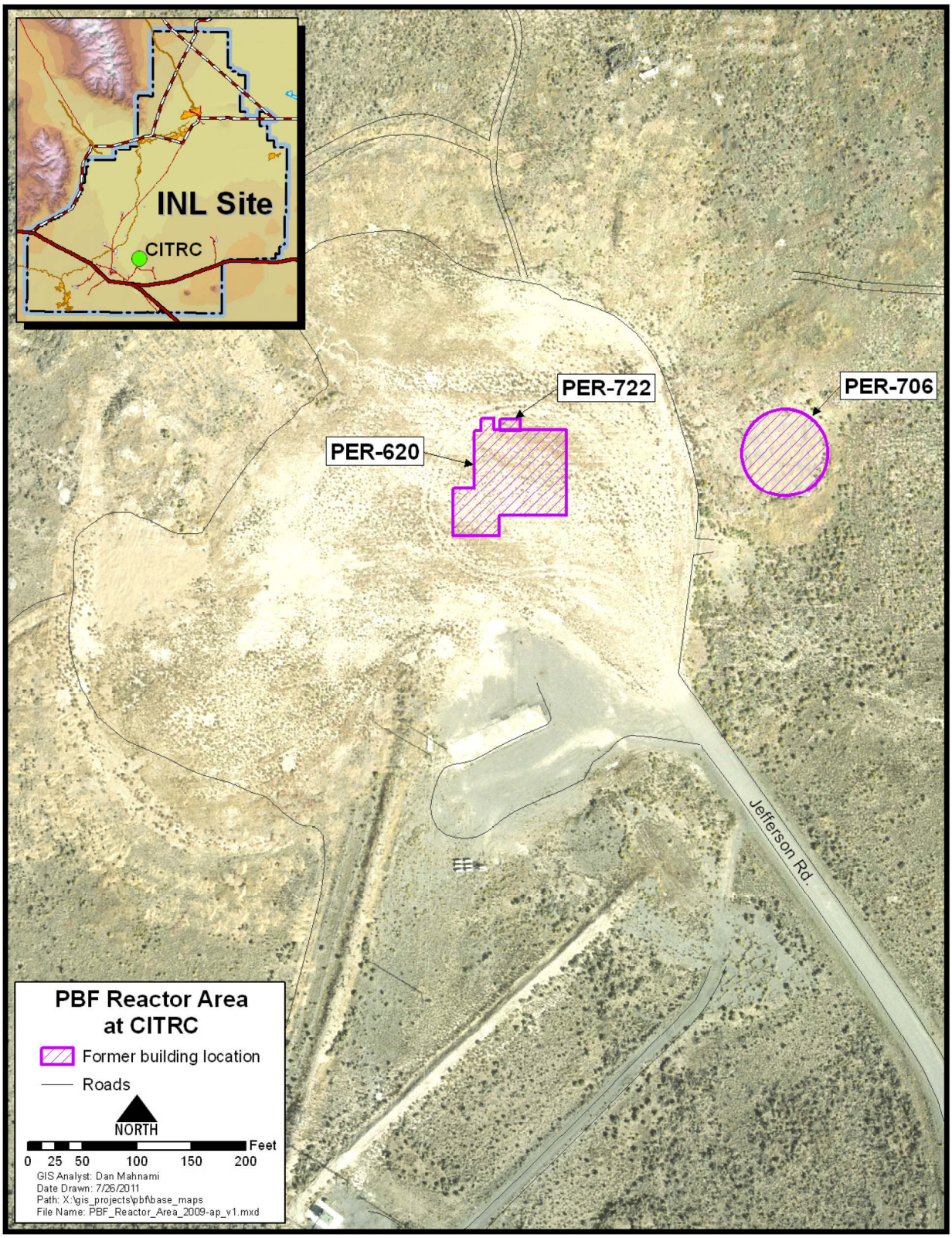

Figure 1. Power Burst Facility Reactor area.

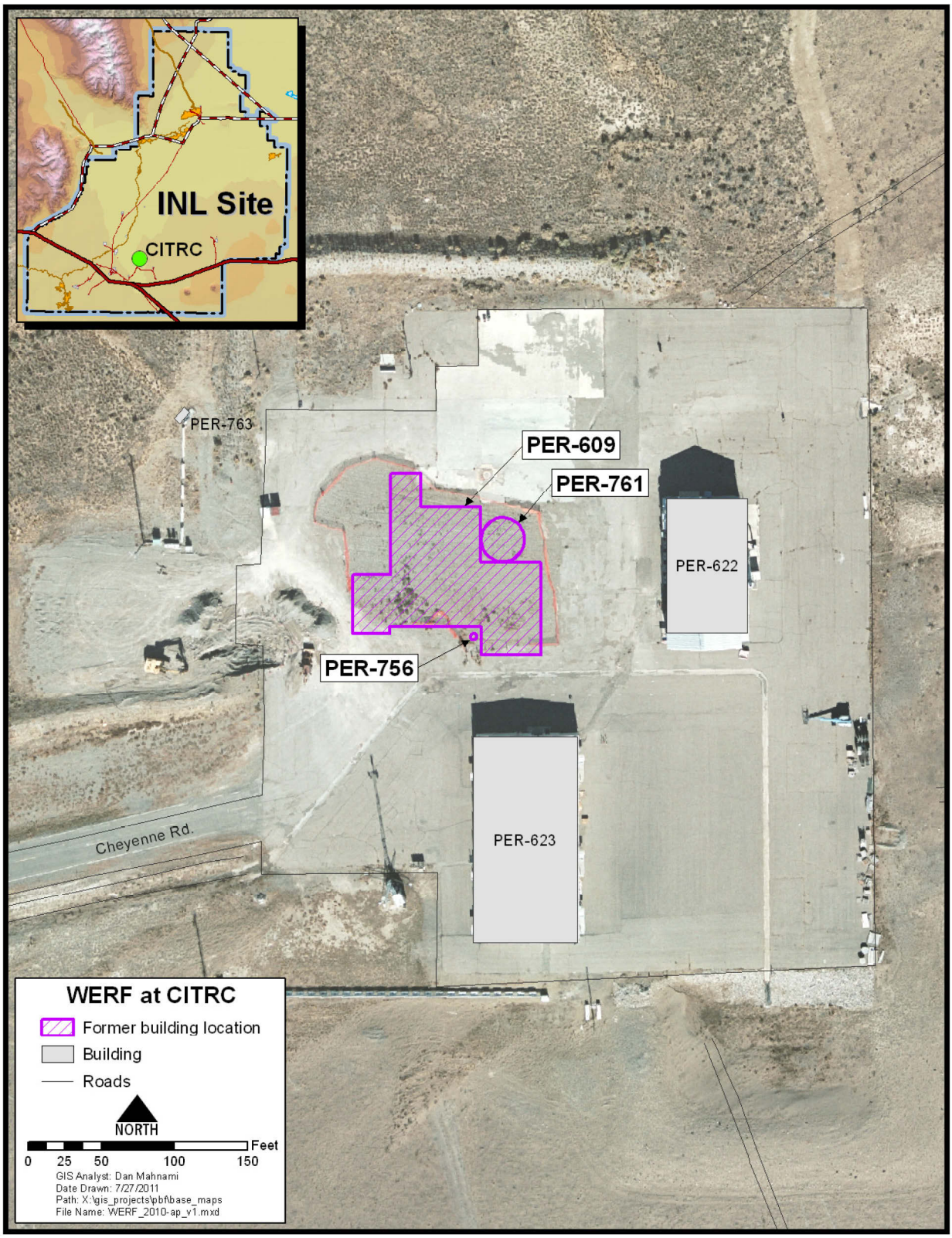

Figure 2. Waste Experimental Reduction Facility area.

completed their missions. PER-609, PER-756, and PER-761 were added to the document via a letter (Cooper 2009) and concurrence obtained from U.S. Environmental Protection Agency (EPA) Region 10 and Idaho Department of Environmental Quality (DEQ) (Faulk 2009; Koch 2009). The three facilities were located in the former WERF/Waste Reduction Operations Complex/PBF area within the INL Site. This approach satisfied environmental review requirements and provided for stakeholder involvement, while providing a framework for selecting the decommissioning alternative. An Administrative Record was established to record information used to support the selected alternative and provide documentation of decisions and the progress of the removal action.

1.3 Removal Action Objectives

The RAOs for the PBF and PBF vessel areas, as identified in the applicable Action Memoranda, were as follows:

- Inhibit direct exposure to radionuclide contaminants of concern (COCs) remaining at PBF that would result in a total excess cancer risk greater than or equal to 1 in 10,000 for current workers and future residents.
- Inhibit dermal adsorption of COCs remaining at PBF that would result in a total excess cancer risk greater than or equal to 1 in 10,000 or a hazard index (HI) of 1 or greater for future residents. To maintain consistency with other Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) risk assessments done at the INL Site and ensure conservatism is maintained in the risk evaluations, the HI of 1 was used in place of the HI of 2 specified in the Operable Unit (OU) 5-12 Record of Decision (ROD).
- Inhibit exposure to contaminated soil that would pose a risk to an ecological receptor.

These removal action goals are consistent with the RAOs for contaminated soil as established in the *Record of Decision Power Burst Facility and Auxiliary Reactor Area Operable Unit 5-12* (DOE-ID 2000). The removal action goals also are predicated on the current and future land uses established for the PBF area in the ROD, which includes a DOE-ID determination that, consistent with the continuing national need for nuclear energy research, the land use will be industrial in nature throughout the 100-year period of analysis in the INL Site land-use planning document (DOE-ID 1995), and most likely will continue to be so for the indefinite future. Actions conducted under this NTCRA will be reviewed with DEQ and EPA for continued protectiveness during the periodic CERCLA 5-year reviews of the remedy for OU 5-12.

The PBF and PBF vessel area removal actions implemented to achieve the RAOs are described in Section 3 of this document.

The RAOs for the WERF (PER-609), exhaust stack (PER-756), and spray dryer absorber (PER-761), as identified in the Action Memorandum, were as follows:

- Prevent external exposure to COCs that would result in cumulative excess carcinogenic risks from multiple COCs to ensure risks remain less than 1 in 10,000 for a hypothetical resident 100 years in the future
- Prevent external exposure to COCs that would result in a HI greater than 1 for a hypothetical resident 100 years in the future
- Prevent future releases to the Snake River Plain Aquifer that would result in migration of contaminants to the aquifer such that Idaho groundwater quality standards may be exceeded and to ensure that cumulative excess carcinogenic risks due to groundwater ingestion from multiple COCs remain less than 1 in 10,000 for a hypothetical resident 100 years in the future

- Prevent unacceptable internal exposure to biota that would result in the lack of maintenance or recovery of healthy local populations/communities of ecological receptors that are or should be present at or near the site.

The removal action goals are consistent with the RAOs established in the *Record of Decision Power Burst Facility and Auxiliary Reactor Area Operable Unit 5-12* (DOE-ID 2000). The removal action goals also are predicated on the current and future land uses established for the PBF area in the ROD, which generally include industrial land use until at least 2095 and the potential for residential land use thereafter. Actions conducted under this NTCRA will be reviewed with DEQ and EPA for continued protectiveness during the periodic CERCLA 5-year review process prescribed under the OU 5-12 ROD.

1.4 Facility Background and Description

1.4.1 Power Burst Facility Description

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 (B_4C) 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. 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 (see Figure 3). 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.

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.

1.4.1.1 PBF Vessel. The PBF vessel (Figure 4) was constructed entirely of Type 304 stainless steel. The overall vessel length was approximately 30 ft and the vessel was approximately 15 ft in diameter with a ½-in.-thick wall. The vessel was supported by a "skirt" that increased the diameter of the vessel to nearly 18 ft. The approximate total weight of the vessel and internals was 113,300 lb (56.7 tons).

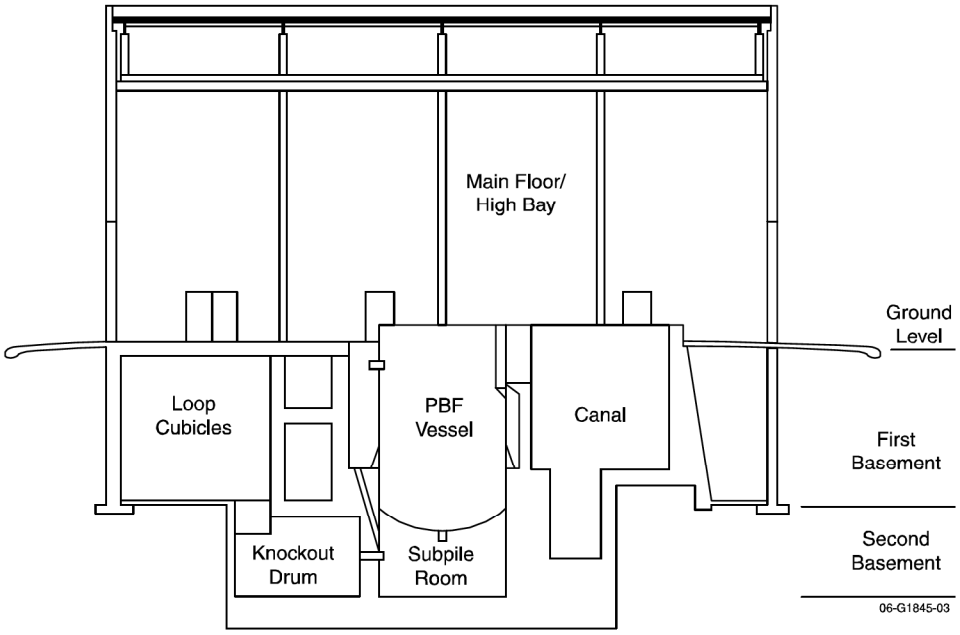

Figure 3. Cutaway rendering of the Power Burst Facility (PER-620) looking east.

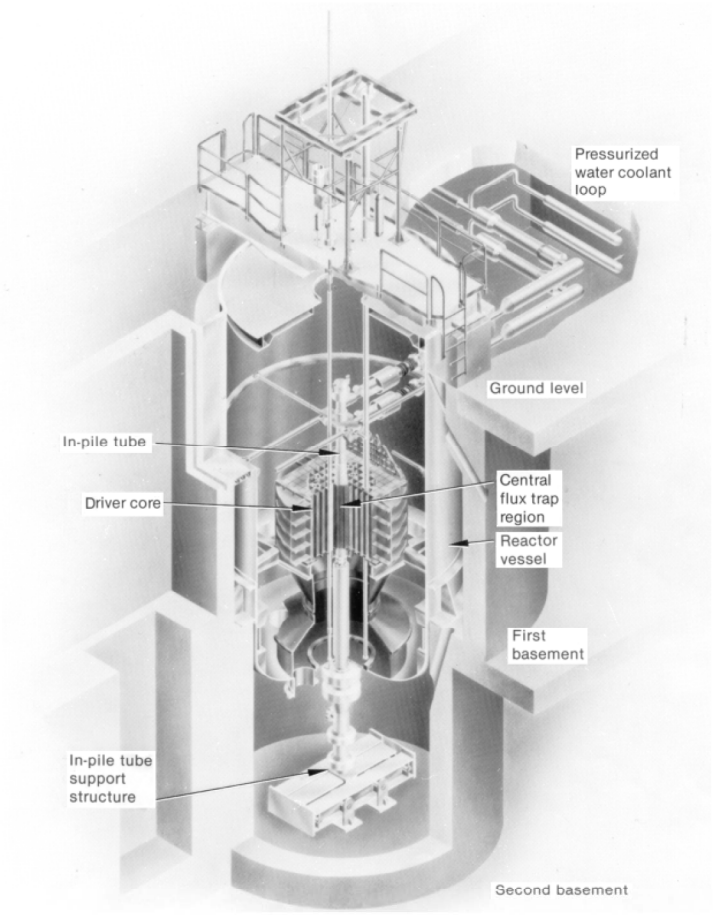

Figure 4. Cutaway rendering of the Power Burst Facility vessel (in-pile tube dispositioned to the Idaho CERCLA Disposal Facility).

The internals of the vessel included 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 connected with the PBF storage canal. Fuel rods, the in-pile tube, and other components were transferred under water between the vessel and the canal through this vessel opening. A reinforced carbon steel cover was installed on the top vessel opening in 2005 when the vessel and canal were drained of primary coolant water.

The decommissioning of PER-620 was conducted in two phases, because the Idaho National Engineering and Environmental Laboratory was in the process of transitioning into separate cleanup and research programs to be known as the Idaho Cleanup Project and INL, respectively. The separation of these programs was scheduled for completion on May 1, 2005. The first phase of the PER-620 decommissioning was completed while the transition was implemented, prior to the scheduled contract start date for the Idaho Cleanup Project. The completion of both phases reduced overall surveillance and maintenance costs at the facility.

1.4.2 Waste Experimental Reduction Facility Description

The Special Power Excursion Reactor Test (SPERT) project was established as part of the Atomic Energy Commission Reactor Safety Program in 1954. In the late 1950s, the PER-609 building was constructed to house the SPERT-III reactor, a high-pressure, light water reactor that first went critical in 1958. Tests conducted in SPERT-III were on a very short transient basis and the reactor was retired in 1968. Early in 1980, a proposal to establish an experimental contaminated metal volume reduction smelter at the INL Site was approved by DOE-ID. An examination of the INL Site facilities showed that either the SPERT-II or the SPERT-III reactor facilities would be suitable for housing this smelter. Because of program needs at that time, which facility would be used for the smelter was unknown, but both would be used if available; consequently, both facilities were returned to use.

The decommissioning and demolition (D&D) of the SPERT-III reactor facility involved the removal of the reactor; removal of reactor piping systems, including pumps, valves, and piping and the heat exchangers; and a complete vacuuming and removal of all debris. This D&D is discussed in "Decontamination and Decommissioning of the SPERT-II and SPERT-III Reactors at the Idaho National Engineering Laboratory" (Hine 1981).

Following D&D of the SPERT-III reactor, the WERF incinerator was constructed in PER-609 and the incinerating of low-level waste commenced in 1984. In February 1991, WERF underwent a planned shutdown to perform major modifications to upgrade facility operating documentation and to re-baseline facility administrative programs. The facility was placed back online in July 1995 for incineration of low-level waste and, in September 1995, for the incineration of mixed low-level waste. WERF consisted of the following systems (see Figure 5):

WERF Incinerator System: The WERF incinerator was a dual-chamber, controlled-air-type incinerator used for thermal treatment of hazardous waste. The incinerator processed boxes of solid waste. The boxes were fed to the incinerator by the solid waste feed conveyor. On the conveyor, the boxes passed through an X-ray system, scale, radiation monitor, and transfer room before being fed to the incinerator. Offgas from the incinerator flowed through a heat exchanger, baghouse filters, high-efficiency particulate air filters, and offgas blowers before being discharged out the north building stack. An ash ram system removed ash, generated in the treatment process, from the incinerator for packaging in drums for disposal.

Figure 5. Waste Experimental Reduction Facility (PER-609), exhaust stack (PER-756), and spray dryer absorber (PER-761).

WERF Drum Feed/Blending Unit: This unit was designed as a liquid feed system to demonstrate that the WERF incinerator could meet applicable standards while burning liquid wastes. This system was only operated during the trial burn in November 1986.

WERF Repackaging Unit: The WERF repackaging unit was used to repackage waste for the treatment in the WERF incinerator. Repackaging activities involved transferring waste from storage drums to the cardboard burn boxes.

PER-756 is the south exhaust stack of the facility. Building air was exhausted through this stack.

PER-761 is a metal grain silo and was used for the storage of non-radioactive absorbing material.

Following shutdown of the WERF incinerator, a Resource Conservation and Recovery Act (RCRA) closure plan was written for the facility (DOE-ID 2001). Closure activities were conducted between 2001 and 2004 and involved the removal of components that had been in contact with, or had the potential to be in contact with, hazardous waste and waste residues. Equipment removed included the following: combustion chambers, ash/ram housing, bottom ash handling system, solid waste feed chute, conveyor system, combustion air system, the primary dilution air system, incinerator offgas ducting, heat exchanger, spark arrestor, secondary dilution air system, baghouse collectors, dust transfer system, offgas blowers, north exhaust stack, WERF drum feed/blending unit, and the remaining components associated with the WERF repackaging unit. Following removal activities, remaining facility surfaces were decontaminated as necessary.

2. REMOVAL ACTION WORK ACTIVITIES

The actions addressed under this removal action were consistent with the following:

- Alternative 2 described in the *Engineering Evaluation/Cost Analysis for Phase 1 of the Decommissioning for the Power Burst Facility Reactor Building (PER-620)* (DOE-NE-ID 2004)
- Alternative 3 described in the *Engineering Evaluation/Cost Analysis for Power Burst Facility (PER-620) Final End State and PBF Vessel Disposal* (DOE-ID 2007b)
- Alternative 2 described in the *Engineering Evaluation/Cost Analysis for General Decommissioning Activities under the Idaho Cleanup Project* (DOE-ID 2006a).

2.1 Demolition Activities Associated with Non-Time-Critical Removal Actions

The PBF reactor was placed on operational standby in 1985 and the fuel rods were removed in summer 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 sealing 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 (see Figure 1 for tank location). Canal Deactivation Project activities were completed in August 2004.

Initial deactivation and decontamination were performed in PER-620 and PBF vessel in accordance with the *Action Memorandum for General Decommissioning Activities under the Idaho Cleanup Project* (DOE-ID 2009) before the Action Memorandum for Decommissioning PER-620 was approved. That document allowed "decommissioning preparatory activities" to go forth in the "more substantial and significant facilities," such as PBF, so work was conducted as decommissioning preparatory activities. This included hazardous waste removal of items such as: mercury vapor lamps and fluorescent bulbs, lead shielding, and circuit boards regulated under the Hazardous Waste Management Act (HWMA)/RCRA and Toxic Substances Control Act; asbestos abatement activities, such as the removal of friable asbestos found in pipe and tank/vessel insulation, fire doors, and other potential asbestos-containing material as required under 40 CFR 61.145, "Standard for Demolition and Renovation"; and removal of other support systems and components from PBF, such as electrical cabinets, hoods, sinks, mixing tanks, the ion exchange columns from Cubicle 10, the warm waste room, and radioactive contaminated piping and tanks, preventing an unacceptable risk.

In June 2002, during routine measuring of an underground heating fuel storage tank located adjacent to the PBF reactor building, an unanticipated decrease in the product level was noticed that suggested that the tank (PER-722; see Figure 1 for tank location) might have released fuel to the subsurface. Further investigation confirmed that heating oil was released from the tank to the subsurface. The remaining heating fuel product was removed from the tank, and the tank was closed in accordance with the appropriate federal, state, and local regulations. Characterization studies, including the installation of borings and a monitoring well completed in the Snake River Plain Aquifer, demonstrated that the aquifer was not impacted by the release. Groundwater monitoring at this site continued through

May 2007 when the well was accepted for no further action (Green 2007), and the well was later abandoned in July 2008.

The WERF incinerator was shut down in 2002. Closure activities were conducted between 2002 and 2004 in compliance with a RCRA Closure Plan (DOE-ID 2001). RCRA closure activities involved the removal of components that had been in contact with, or had the potential to be in contact with, hazardous waste and waste residues. Equipment removed included the following: combustion chambers, ash/ram housing, bottom ash handling system, solid waste feed chute, conveyor system, combustion air system, the primary dilution air system, incinerator offgas ducting, heat exchanger, spark arrestor, secondary dilution air system, baghouse collectors, dust transfer system, offgas blowers, north exhaust stack, WERF drum feed/blending unit, and the remaining components associated with the WERF repackaging unit. Following removal activities, remaining facility surfaces were decontaminated as necessary.

D&D actions were performed in PER-609, PER-756, and PER-761 in accordance with Alternative 2 of the *Action Memorandum for General Decommissioning Activities under the Idaho Cleanup Project* (DOE-ID 2009). The addendum to add the buildings to the EE/CA and Action Memorandum were approved in March 2009 (Koch 2009; Faulk 2009).

2.1.1 Phase 1 PER-620 Activities

The Action Memorandum for PER-620 was approved by the Agencies in February 2005 (DOE-NE-ID 2005). The PBF reactor operated from 1972–1985 to conduct tests of reactor fuel in extreme environments. Alternative 2 was the chosen approach for the removal action, as documented in the Phase 1 PER-620 Action Memorandum. Alternative 2 consisted of taking steps to place the facility in a condition that would facilitate the final decommissioning; specifically, PER-620 contained radioactive materials and heavy metals of concern which were removed. The reactor vessel contained contaminated water that provided shielding for the irradiated components inside the vessel. Contaminated water also was present in the piping for the primary coolant system. Decommissioning work accomplished during the Phase 1 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 1 was completed at the end of April 2005, with the exception of the demolition of the PER-706 evaporation tank. The liquids in the tank, mostly primary and secondary coolant water, were allowed to evaporate during summer and fall 2005. The remaining liquid and sediment were disposed of at the ICDF, and the tank was demolished in November 2005.

2.1.2 PER-620 Final End State and PBF Vessel Disposal

The Action Memorandum for Final End State of PER-620 and PBF Vessel Disposal was approved by DOE-ID, EPA, and DEQ in June 2007 (DOE-ID 2007a). Decommissioning activities began on PBF in February 2005 with approval of the *Action Memorandum for Phase 1 of the Decommissioning for the Power Burst Facility Reactor Building (PER-620)* (DOE-NE-ID 2005). Activities preparatory to the final end state and vessel disposal determination began again at PBF in October 2006 under the *Action Memorandum for General Decommissioning Activities under the Idaho Cleanup Project* (DOE-ID 2006b). All support buildings and other structures had been removed prior to initiation of the final end state decommissioning of PER-620 (Phase 2). Phase 1 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 *Action Memorandum for Phase 1 of the Decommissioning for the Power Burst Facility Reactor Building (PER-620)* (DOE-NE-ID 2005). 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. Radioactivity is measured in a unit of activity called a curie (Ci). Activity is the rate a radiological isotope will decay by emitting ionizing particles, such as alpha and beta particles, or energy, such as gamma rays. There was an estimated total of 21.8 Ci associated with the PBF vessel.

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.

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.

2.1.3 D&D Activities for PER-609, PER 756, and PER-761

The Action Memorandum for General D&D was approved in October 2006. Approval to add PER-609, PER-756, and PER-761 was obtained from DOE-ID, EPA, and DEQ in 2009. D&D actions for WERF began in June 2009. In 2004, prior to the D&D actions, RCRA closure was completed in compliance with an approved RCRA Closure Plan (DOE-ID 2001).

RCRA closure activities included the following equipment removal and disposal: combustion chambers, ash/ram housing, bottom ash handling system, solid waste feed chute, conveyor system, combustion air system, the primary dilution air system, incinerator offgas ducting, heat exchanger, spark arrestor, secondary dilution air system, baghouse collectors, dust transfer system, offgas blowers, north exhaust stack, WERF drum feed/blending unit, and the remaining components associated with the WERF repackaging unit. Following removal activities, remaining facility surfaces were decontaminated as necessary.

D&D actions included removal and disposal of lead, cadmium, polychlorinated biphenyl-containing capacitors, and asbestos-containing materials. All abovegrade structures, including WERF, the exhaust stack, and spray dryer absorber, were demolished and removed for disposal at the ICDWL. The belowgrade structure (PER-609 basement) was backfilled with clean fill material and graded to match the surrounding area. All water and sewer connections to PER-609 were isolated. Electrical and fire water utilities were isolated from PER-609 and rerouted as necessary for support of remaining Critical Infrastructure Test Range Complex facilities.

Two areas containing residual radioactive contamination were in the PER-609 basement. The first area was the sump located in Room B101 and the other was the floor of Room B106. The B101 sump had total beta-gamma contamination levels as high as 70,000 dpm/100 cm^2. The floor of B106 had small isolated areas with total beta-gamma contamination levels as high as 30,000 dpm/100 cm^2 (Nesshoefer 2009).

2.2 Final Status

2.2.1 Completion of Removal Actions

As identified in the Action Memoranda, following demolition actions, the PBF and vessel areas were backfilled with solid inert material. The final step was to seed the area with a native vegetative cover. The seeding was completed in October 2009 (see Figure 6).

As identified in the Action Memorandum, following demolition actions, the previous location of WERF, exhaust stack, and spray dryer absorber was backfilled with clean fill material and graded to match the surrounding area. The removal action was completed in September 2009 (see Figure 7).

2.2.2 PER-620 Waste Disposition

The volume of waste dispositioned as part of this PBF-620 NTCRA is as follows:

- Mixed waste dispositioned to EnergySolutions and Nevada Test Site: 534 ft^3
- CERCLA contaminated waste dispositioned in ICDF: 86,595 ft^3
- CERCLA liquid to ICDF evaporation ponds: 42,215 gal.

Figure 6. Location of former Power Burst Facility reactor building after seeding and mulching.

Figure 7. Location of former Waste Experimental Reduction Facility, exhaust stack, and spray dryer absorber after grading.

2.2.3 PER-620 Cost

Total project cost for demolition activities associated with implementing the PBF (PER-620) and PBF vessel disposal NTCRA was $5,829K.

2.2.4 PER-609 Waste Disposition

The volume of waste dispositioned as part of this WERF NTCRA is as follows:

- Hazardous waste dispositioned to Clean Harbors: 55-gal drum or 7.4 ft^3
- CERCLA non-contaminated waste dispositioned in ICDWL: 21,087 ft^3.

2.2.5 PER-609 Cost

Total project cost for demolition activities associated with implementing the WERF, exhaust stack, and spray dryer absorber NTCRA was $693K.

2.2.6 Institutional Controls

All contaminants that exceeded RAOs were removed to meet the removal action goals. Therefore, no institutional controls were implemented in the PBF or WERF areas for this NTCRA. Details regarding institutional controls at all areas of the INL Site are discussed in the *INL Site-wide Institutional Controls and Operations and Maintenance Annual Report – FY-2010 (*RPT-759).

3. ACHIEVING REMOVAL ACTION OBJECTIVES

Implementing this removal action was consistent with the RAOs established in the *Record of Decision Power Burst Facility and Auxiliary Reactor Area Operable Unit 5-12* (DOE-ID 2000). As such, the removal action was consistent with and will contribute to the overall closure of PBF and the Auxiliary Reactor Area under CERCLA (42 USC § 9601 et seq.). The RAOs identified in Section 4.2 of the Phase 1 Action Memorandum (DOE-NE-ID 2005), Section 4.2 of the General D&D Action Memorandum (DOE-ID 2009), and Section 5.1 of the Final End State Action Memorandum (DOE-ID 2007a) were to reduce the risk from external radiation exposure to a total excess cancer risk of less than 1 in 10,000 for future residents and for current and future workers. Per the OU 5-12 ROD, PBF will be under the control of the government until at least 2095. In addition, at the INL Site, the standard for protecting the Snake River Plain Aquifer is to prevent any release that could result in exceedances of the maximum contaminant level and ensure that the site is available for unrestricted use in the future. The RAOs were met as identified in the following subsections.

3.1 Phase 1 for the Power Burst Facility Reactor Building (PER-620)

Phase 1 D&D activities addressed those activities that could be completed prior to scheduled INL contract end date for the Idaho Completion Project and before the Idaho Cleanup Project under CH2M-WG Idaho, LLC, took responsibility for decommissioning. Following Phase 1 activities, immediate risk from contaminants was minimized. Items that could have been considered HWMA/RCRA hazardous waste, asbestos, and chlorofluorocarbons were removed, along with liquids as determined by the NTCRA process. These actions placed PBF in an interim end state and reduced overall surveillance and maintenance costs at the facility.

3.1.1 PER-620 Radiological Contamination

Based on radiological characterization data of the PER-620, following demolition of the building, the estimated source term remaining in the facility is 3.93 Ci, of which 0.036 Ci exists in the 0 to 10-ft belowgrade region. The total U-235 holdup remaining in the building following demolition is 0.035 g. The RAO has been met because the remaining Cs-137 in the 0 to 10-ft belowgrade interval is less than the 0.2-Ci Cs-137 action level established through the CERCLA NTCRA process.

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.

3.2 Final End State for PER-620 and Vessel Disposal

As identified in the PBF Final End State Action Memorandum, radiological debris that did not meet the RAOs was removed from the area and disposed of at ICDF, including the PBF vessel. As stated in the Action Memorandum, less than 0.2 Ci of total activity, including Cs-137, was to remain from 0 to 10 ft below ground level. Below the 10-ft interval, less than 4.7 Ci of activity would remain. The "Power Burst Facility (PBF) Radiological End State Source Term" (EDF-8708) discusses the radiological surveys and end-state source term calculations for PER-620. The actual residual radiological source term was calculated to be 3.93 Ci for the facility, with 0.036 Ci in the 0 to 10-ft belowgrade interval. The vessel void was backfilled as practical and grouted as needed to stabilize the internal reactor components.

During final preparations to complete PBF and vessel demolition, D&D reviewed potential nonradiological materials that had not been previously removed. Nonradiological characterization, decontamination, and removal were conducted, which included potential HWMA/RCRA and Toxic Substances Control Act materials. Boron from the PBF vessel poison rods was removed. Aluminum, chromium, lead, manganese, nickel, selenium, and zinc materials of regulatory concern were removed.

Risks from remaining contaminants were brought down within the acceptable range established by EPA. The greatest quantities of materials were those used in the construction of equipment and components for nuclear operations (primarily stainless steel), including the PBF vessel and components; piping, valves, and tanks; and materials required to provide necessary radiation shielding for nuclear operations. Thus, most of the mass accounted for in this inventory consists of chromium and nickel, which are the principal elements (for hardening and corrosion resistance) in stainless steel.

The entire abovegrade structure, with the exception of the main floor slab, was removed. The main floor slab was placed at a depth greater than 10 ft below ground during demolition. Abovegrade equipment and piping, along with all contaminated piping systems and equipment in the first basement, reactor annulus, sample room, and loop tunnel, were removed. With the exception of the blowdown tank, all contaminated piping systems and equipment were removed from Cubicle 13. Being deeper than 10 ft below grade, leaving the second basement did not interfere with meeting RAOs.

3.3 Waste Experimental Reduction Facility (PER-609)

3.3.1 PER-609 Contamination

In compliance with a RCRA Closure Plan (DOE-ID 2001), RCRA closure actions were performed at WERF from 2001 through 2004. Radionuclides associated with the waste generated during the RCRA closure of WERF are documented in the Integrated Waste Tracking System profile 3073N. This profile documents the radionuclides and the percentage that the radionuclides contributed to the total volume of the RCRA-generated waste for both beta-gamma and alpha activity. The percentage was corrected for 7 years of decay (decay time from when the profile was generated in 2009).

During final preparations to complete WERF demolition, exhaust stack, and the spray dryer absorber, D&D reviewed potential nonradiological materials that had not been previously removed. Nonradiological characterization, decontamination, and removal were conducted, which included potential HWMA/RCRA and Toxic Substances Control Act materials. Aluminum, chromium, lead, manganese, nickel, selenium, and zinc materials of regulatory concern were removed.

The only known areas containing residual radioactive contamination were in the PER-609 basement. The first area was the sump located in Room B101 and the other was the floor of Room B106. These rooms are shown in Figure 8.

The B101 sump had total beta-gamma contamination levels as high as 70,000 dpm/100 cm^2. The fixed surface contamination on concrete associated with the B101 sump was in a cable duct, which routed electrical cables to the metal melt furnace. The contamination is not attributed to a release of reactor coolants or other radioactive liquids and the sump was not used for support of SPERT-III reactor operations. The metal melt furnace supported operation of the WERF and was used to melt potentially contaminated metals into a final waste form for disposal. A considerable number of sparks emanated from the furnace crucible during melting and pouring, and these are considered proportional to particulate radioactive contamination present in the furnace room. There was no evidence of the contamination extending beyond the fixed surface contamination of the concrete. The floor of B106 had small isolated areas with total beta-gamma contamination levels as high as 30,000 dpm/100 cm^2.

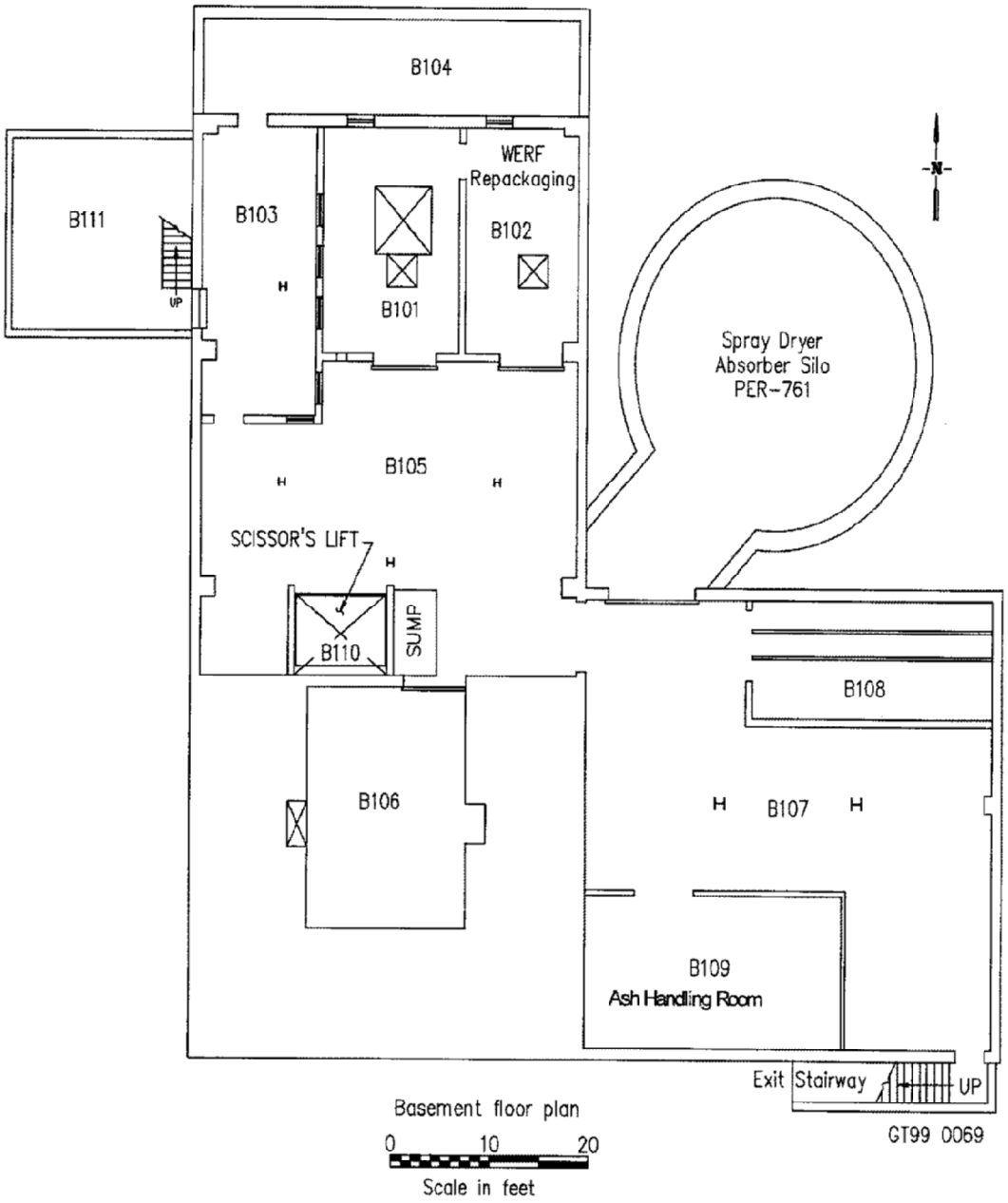

Figure 8. PER-609 basement floor plan.

Based on the analysis performed in "PER-609, PER-761, & PER-756 Pre-Demolition Source Term," the total source term associated with these facilities was 3.01E-05 Ci. The predominate radionuclides, in terms of activity, contributing to this source term were Cs-137 (55.99%), Pm-147 (19.25%), Tc-99 (9.09%), and Sr-90 (7.40%). The DOE-STD-1027-92 HAZCAT-III sum-of-the-ratios values calculated from the source term was 1.07E-06; thus, the facility was less than HAZCAT-III (Nesshoefer 2009).

With the exception of the B101 sump, all contaminants were removed. All abovegrade structures were demolished and removed for disposal, and the PER-609 basement was backfilled with clean fill material and graded to match the surrounding area.

A conservative screening-level groundwater risk assessment was performed for residual radionuclides in PER-609 (EDF-10033). The predicted risks are at least 100,000 times less than the 1E-04 risk standard. The largest predicted risk is for U-238, with a risk of 1E-09. The predicted peak risks are almost four orders of magnitude less than the maximum contaminant levels, and the residual risk at PER-609 meets the RAOs of the OU 5-12 ROD (DOE-ID 2000). The results of the screening-level groundwater risk assessment are shown in Table 1.

Table 1. Results from screening-level groundwater risk calculations using GWSCREEN.

Radionuclides	Progeny	MCL (pCi/L)	Initial Inventory (Ci)	Half-Life (yr)	Risk Slope Factor[a] (1/Ci)	Source and Vadose Zone Kd[b] (mL/g)	Time to Peak (yr)	Peak Concentration (pCi/L)	30-Year Average Peak Concentration (pCi/L)	Peak Risk[c]	Total Risk
Cs-137		200	1.69E-05	3.01E+01	3.04E+01	500	NA	0.00E+00	0.00E+00	0.00E+00	0E+00
Eu-152		200	6.52E-09	1.35E+01	6.07E+00	340	NA	0.00E+00	0.00E+00	0.00E+00	0E+00
Eu-154		60	4.96E-09	8.59E+00	1.03E+01	340	NA	0.00E+00	0.00E+00	0.00E+00	0E+00
Eu-155		600	9.93E-10	4.76E+00	1.90E+00	340	NA	0.00E+00	0.00E+00	0.00E+00	0E+00
K-40		No MCL	6.23E-07	1.27E+09	2.47E+01	15	2,371	7.79E-04	4.57E-04	2.37E-10	2E-10
Nb-94		No MCL	8.52E-08	2.03E+04	7.77E+00	100	15,631	9.50E-06	6.60E-06	1.08E-12	1E-12
Np-237		15	3.69E-08	2.14E+06	6.74E+01	8	1,279	8.54E-05	4.27E-05	6.04E-11	6E-11
	U-233			1.59E+05	7.18E+01			4.75E-07	2.40E-07	3.62E-13	
	Th-229			7.34E+03	5.28E+02			2.76E-08	1.41E-08	1.56E-13	
Pu-238 (as U-234)		0.03 mg/L[d]	3.14E-12	2.46E+05	7.07E+01	6	967	9.58E-09	4.31E-09	6.40E-15	7E-15
	Th-230			7.54E+04	9.10E+01			8.49E-11	3.87E-11	7.39E-17	
	Ra-226			1.60E+03	3.86E+02			1.56E-11	7.17E-12	5.81E-17	
	Pb-210			2.23E+01	1.27E+03			1.46E-11	6.74E-12	1.80E-16	
Pu-239		15	4.09E-08	2.41E+04	1.35E+02	22[e]	3,463	3.17E-05	1.98E-05	5.61E-11	6E-11
	U-235			7.04E+08	7.18E+01			1.14E-10	7.13E-11	1.07E-16	
	Pa-231			3.28E+04	1.73E+02			4.13E-12	2.60E-12	9.43E-18	
	Ac-227			2.18E+01	4.86E+02			4.06E-12	2.55E-12	2.60E-17	
Pu-240		15	4.08E-08	6.56E+03	1.35E+02	22[e]	3,463	2.43E-05	1.51E-05	4.28E-11	4E-11
	U-236			2.34E+07	6.70E+01			3.00E-09	1.88E-09	2.65E-15	
	Th-232			1.41E+10	1.01E+02			2.71E-16	1.71E-16	3.62E-22	
	Ra-228			5.75E+00	1.04E+03			2.70E-16	1.70E-16	3.71E-21	
	Th-228			1.91E+00	3.00E+02			2.70E-16	1.70E-16	1.07E-21	
Ra-226		No MCL	2.78E-07	1.60E+03	3.86E+02	100	15,631	6.05E-08	4.18E-08	3.39E-13	1E-12
	Pb-210			2.23E+01	1.27E+03			6.14E-08	4.24E-08	1.13E-12	
Sr-90		8	2.23E-06	2.88E+01	7.40E+01	12[f]	1,903	4.43E-23	1.84E-23	2.86E-29	3E-29
Tc-99		900	2.74E-06	2.11E+05	2.75E+00	0.2	62	1.23E-01	6.794E-03	3.92E-10	4E-10
U-233			1.88E-07	1.59E+05	7.18E+01	6	967	5.72E-04	2.58E-04	3.88E-10	6E-10
	Th-229			7.34E+03	5.28E+02			5.01E-05	2.28E-05	2.53E-10	

Table 1. (continued).

Radionuclides	Progeny	MCL (pCi/L)	Initial Inventory (Ci)	Half-Life (yr)	Risk Slope Factor[a] (1/Ci)	Source and Vadose Zone Kd[b] (mL/g)	Time to Peak (yr)	Peak Concentration (pCi/L)	30-Year Average Peak Concentration (pCi/L)	Peak Risk[c]	Total Risk
U-234		0.03 mg/L[d]	4.26E-07	2.46E+05	7.07E+01	6	967	1.30E-03	5.85E-04	8.68E-10	9E-10
	Th-230			7.54E+04	9.10E+01			1.15E-05	5.25E-06	1.00E-11	
	Ra-226			1.60E+03	3.86E+02			2.11E-06	9.73E-07	7.88E-12	
	Pb-210			2.23E+01	1.27E+03			1.99E-06	9.15E-07	2.44E-11	
U-235		0.03 mg/L[d]	2.71E-08	7.04E+08	7.18E+01	6	967	8.29E-05	3.73E-05	5.62E-11	7E-11
	Pa-231			3.28E+04	1.73E+02			1.68E-06	7.64E-07	2.78E-12	
	Ac-227			2.18E+01	4.86E+02			1.62E-06	7.40E-07	7.55E-12	
U-236		0.03 mg/L[d]	2.93E-09	2.34E+07	6.70E+01	6	967	8.96E-06	4.03E-06	5.67E-12	6E-12
	Th-232			1.41E+10	1.01E+02			4.26E-13	1.94E-13	4.12E-19	
	Ra-228			5.75E+00	1.04E+03			4.22E-13	1.92E-13	4.20E-18	
	Th-228			1.91E+00	3.00E+02			4.21E-13	1.92E-13	1.21E-18	
U-238		0.03 mg/L[d]	3.96E-07	4.47E+09	8.71E+01	6	967	1.21E-03	5.45E-04	9.97E-10	1E-09
	U-234			2.46E+05	7.07E+01			3.30E-06	1.50E-06	2.23E-12	
	Th-230			7.54E+04	9.10E+01			1.46E-08	6.74E-09	1.29E-14	
	Ra-226			1.60E+03	3.86E+02			1.85E-09	8.61E-10	6.98E-15	
	Pb-210			2.23E+01	1.27E+03			1.68E-09	7.84E-10	2.09E-14	

a. Risk slope factors from EPA (1999).

b. Kd values from DOE-ID (1994) or Jenkins (2001).

c. Risk = C × I (2 L/d) × EF (350 d/y) × ED (30 y) × RSF (risk/Ci) × 1E-12 Ci/pCi., C = 30-year average peak water concentration., I = water ingestion rate, EF = exposure frequency, ED = exposure duration, RSF = risk slope factor (risk/Ci).

d. The MCL for uranium is a chemical-based total uranium limit of 0.03 mg/L. The peak mass-based concentration in the aquifer for each uranium isotope is: U-233 = 5.93E-11, U-234 = 2.08E-10, U-235 = 3.83E-08, U-236 = 1.38E-10, and U-238 = 3.59E-06 mg/L. The peak predicted total uranium concentration is 3.6E-06 mg/L or 8,000 times less than the MCL of 0.03 mg/L.

e. Plutonium Kd has been shown to be much larger than 22 mL/g, but the Track 2 value is used here for screening purposes.

f. Sr-90 Kd is defined as 24 mL/g in DOE-ID (1994). However, one-half that value has commonly been used at the INL Site for screening over the last 10 years. Therefore, 12 mL/g is used for this screening-level evaluation.

MCL maximum contaminant level
NA not applicable

4. LESSONS LEARNED

4.1 Demolition of PBF and WERF

During transport of the PBF vessel from the PER-620 location to ICDF, levelers on the transport trailer failed en route near the former PBF control area. The failure of the levelers on the trailer created the potential for the load that was strapped onto the trailer to contact the ground and/or roll the trailer onto its side. The shipment was immediately halted, and the load was hoisted with a crane from the trailer with the failed levelers and placed onto a different trailer and strapped down for continued shipment to the ICDF. The transfer was accomplished within 24 hours, and the load did not contact the ground, nor roll the trailer with the failed levelers. The levelers on heavy transport trailers should be closely inspected prior to use for heavy and/or radiological loads.

During preparations for demolition at WERF, a kestrel nest with eggs was identified on the east side of Building PER-609. Additionally, a swallow's nest with eggs was found under the entry portico on the north side of PER-609. Interfering with the nests containing eggs and hatchlings is contrary to the requirements of the "Migratory Bird Treaty Act" (16 USC 703 et seq.). Protective barriers were placed around the nests to prevent human disturbance of the nests. The eggs in the kestrel nest did not hatch and are believed to have been removed from the nest by a predator (possibly a raven). The hatchlings were still in the swallow's nest at the time demolition was scheduled to begin. A removal permit was obtained from U.S. Fish and Wildlife Service to relocate the hatchlings from the nest to a licensed bird rehabilitator in Salmon, Idaho. Precautions and surveillance should occur on buildings scheduled for demolition during the nesting season to prevent nest-building (and breeding) of migratory birds.

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Appendix A

Photographs of PER-620 and PBF Vessel Demolition in Progress

Appendix A

Photographs of PER-620 and PBF Vessel Demolition in Progress

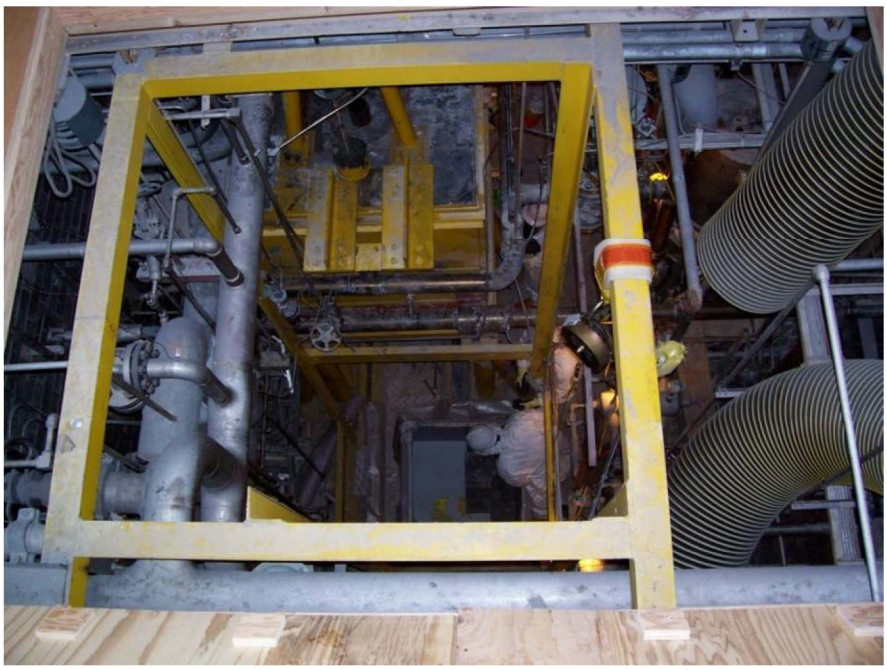

Figure A-1. Power Burst Facility Cubicle 10 before removal.

Figure A-2. Power Burst Facility Cubicle 10 after removal.

Figure A-3. Power Burst Facility Cubicle 13 before hot spot removal.

Figure A-4. Power Burst Facility Cubicle 13 after hot spot removal.

Figure A-5. Power Burst Facility demolition.

Figure A-6. Power Burst Facility vessel removal.

Figure A-7. Power Burst Facility vessel move to the Idaho CERCLA Disposal Facility.

Appendix B

Photographs of PER-609, PER-756, and PER 761 Demolition in Progress

Appendix B

Photographs of PER-609, PER-756, and PER 761 Demolition in Progress

Figure B-1. Waste Experimental Reduction Facility building, exhaust stack, and spray dryer absorber during demolition (09/03/2009).

Figure B-2. Waste Experimental Reduction Facility building, exhaust stack, and spray dryer absorber during demolition (09/09/2009).

Figure B-3. Waste Experimental Reduction Facility spray dryer absorber during demolition.