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Revision 0

Removal Action Report for the Engineering Test Reactor Building and Disposition of the Reactor Vessel

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DOE Idaho Operations Office

ABSTRACT

This Removal Action Report describes the actions taken to bring the Engineering Test Reactor building at the Idaho National Laboratory Site to a final end state. It also describes the final end state of the reactor vessel. These end states were achieved under the non-time-critical removal action recommended in the *Action Memorandum for Decommissioning the Engineering Test Reactor Complex under the Idaho Cleanup Project* as evaluated in the *Engineering Evaluation/Cost Analysis for Decommissioning of the Engineering Test Reactor Complex.*

The Engineering Test Reactor building was demolished to below ground level. Actions taken also consisted of removing and disposing of asbestos, lead, cadmium, and low-level radioactive liquids, and ensuring that materials left in the reactor building met the removal action objectives. The reactor vessel was removed and disposed of on-Site at the Idaho CERCLA Disposal Facility. Lower portions of the basement levels, including the hot and cold waste tank vaults and General Electric Experimental Loop tunnel, were filled with grout. The basements and excavated areas were then backfilled with inert material; after which, the area was graded and covered with clean soil.

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ACRONYMS

ARAR	applicable, relevant, and appropriate requirement
ATR	Advanced Test Reactor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
COC	contaminant of concern
D&D	deactivation and decommissioning
EE/CA	engineering evaluation/cost analysis
ETR	Engineering Test Reactor
GEEL	General Electric Experimental Loop
HWMA	Hazardous Waste Management Act
ICDF	Idaho CERCLA Disposal Facility
INL	Idaho National Laboratory
NTCRA	non-time-critical removal action
OU	operable unit
PCB	polychlorinated biphenyl
RAO	removal action objective
RAR	removal action report
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
WAC	waste acceptance criteria

Removal Action Report for the Engineering Test Reactor Building and Disposition of the Reactor Vessel

1. INTRODUCTION

This Removal Action Report (RAR) describes actions taken to bring the Engineering Test Reactor (ETR) building (TRA-642) within the Advanced Test Reactor (ATR) Complex at the Idaho National Laboratory (INL) Site to a final end state. It also describes the final end state of the reactor vessel. Deactivation and decommissioning (D&D) work began in October 2005, and all D&D work was completed by March 2008.

1.1 Purpose and Objective

This RAR describes actions taken under the non-time-critical removal action (NTCRA) recommended in the Action Memorandum for Decommissioning the ETR Complex (DOE-ID 2007). This RAR also confirms that actions taken under the NTCRA were consistent with Alternative 3 (selected alternative), as evaluated in the Engineering Evaluation/Cost Analysis (EE/CA) for Decommissioning of ETR (DOE-ID 2006). Alternative 3 was the selected alternative identified in the 2007 Action Memorandum.

This RAR demonstrates that actions that were taken met—and were consistent with—the remedial action objectives of the Final Record of Decision (ROD) for Test Reactor Area (TRA) Operable Unit (OU) 2-3 (DOE-ID 1997) and support the overall remediation goals established through the Federal Facility Agreement and Consent Order (DOE-ID 1991).

This RAR also discusses actions taken under other regulatory programs that contributed to the final end state of the reactor building and the disposition of the reactor vessel.

1.2 Scope

The scope of the removal actions for the ETR Complex included achieving the end state defined in the 2007 Action Memorandum and disposal of the ETR vessel at the Idaho CERCLA Disposal Facility (ICDF). The ETR Complex consisted of the reactor building (TRA-642) and various other associated buildings and structures. This RAR addresses only the reactor building and disposition of the reactor vessel. All other ETR Complex buildings and structures are addressed in the *Completion Reports for the Action Memorandum for General Decommissioning Activities Under the Idaho Cleanup Project* (RPT-720).

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 documenting the implemented actions.

1.3 Removal Action Objectives

Removal action objectives (RAOs) for the NTCRA were to perform final decommissioning of ETR, consistent with the OU 2-13 RAOs established in the TRA OU 2-3 ROD (DOE-ID 1997), to achieve the following:

- Inhibit direct exposure to radionuclide contaminants of concern (COCs) that would result in a total excess cancer risk greater than 1 in 10,000 to 1 in 1,000,000 for current and future workers and future residents
- Inhibit ingestion of radionuclide and nonradiological COCs by all affected exposure routes (including groundwater, soil, and homegrown-produce ingestion) that would result in a total excess cancer risk greater than 1 in 10,000 to 1 in 1,000,000 or a hazard index of 1 or greater for current and future workers and future residents
- Inhibit adverse effects to flora and fauna—as determined from the ecological risk evaluation—from COCs in the soil, surface water, and air.

Although decommissioning ETR was not specifically addressed in the TRA OU 2-3 ROD, these removal action goals are consistent with the RAOs for contaminated soil established in that document. The removal action goals also are predicated on the current and future land uses established in the TRA OU 2-3 ROD, including industrial land use until at least 2095 and the potential for residential land use thereafter.

1.4 Chronology of Events

Continuous, active onsite deactivation and decommissioning (D&D) of the ETR building began in October 2005. D&D crews began mobilizing personnel, personnel trailers, tool and parts trailers, waste-handling materials and containers, and equipment to support bringing the ETR building and reactor to their final end state. Work was completed in March 2008 when the belowgrade levels were backfilled, and a cover of clean soil and gravel was applied over the former location of the ETR building (TRA-642). Table 1-1 lists the chronology of major events that led to the ETR final end state.

Table 1-1. Engineering Test Reactor deactivation and decommissioning chronology of events.

Date	Activity
October 2005	Began deactivation and hazardous materials removal activities
December 2005	Received approval to proceed with preparation of ETR EE/CA (Provencher 2005)
October 2006	Finalized the ETR EE/CA (DOE-ID 2006)
January 2007	Received approval of the ETR Action Memorandum (DOE-ID 2007)
September 2007	Transported the ETR reactor to ICDF for disposal
March 2008	Completed demolition of TRA-642 (ETR reactor building) demolition, and backfilled the basement levels

EE/CA engineering evaluation/cost analyses
ETR Engineering Text Reactor
ICDF Idaho CERCLA Disposal Facility

2. BACKGROUND OF THE ENGINEERING TEST REACTOR

2.1 Location

The reactor building (TRA-642) was located at the ATR Complex (Figure 2-1), which is part of the INL Site (Figure 2-2). Historically, the ATR Complex was titled the Reactor Technology Complex, but was originally known as TRA.

2.2 History

The ETR Complex was constructed between 1955 and 1957, with subsequent modifications completed in 1960 and 1972. The reactor first became operational in 1957. At the time it entered service, ETR was the largest, most advanced nuclear fuels and materials test reactor in the United States at 175 MWth (megawatt thermal). After initial testing of the reactor, full power operation was achieved in 1958. In 1972, a decision was made to have ETR support the U.S. Department of Energy's breeder reactor safety program. Conversion of the reactor for this purpose started in May 1973. The new assignment focused on safety programs relating to reactor fuel, core design, and operation for the liquid metal fast-breeder reactor program.

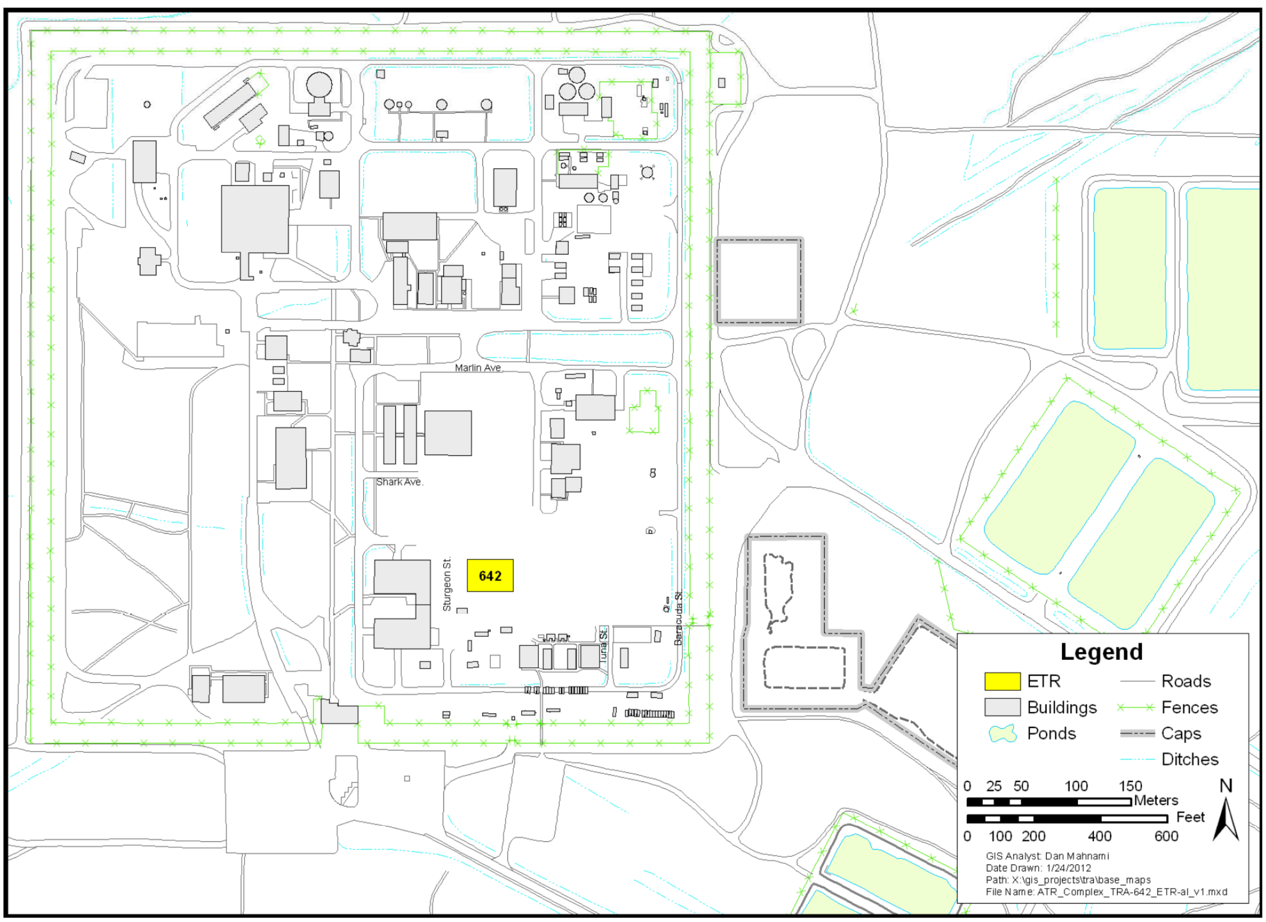

Figure 2-1. Line drawing of the Advanced Test Reactor Complex showing the former location of the Engineering Test Reactor building (TRA-642).

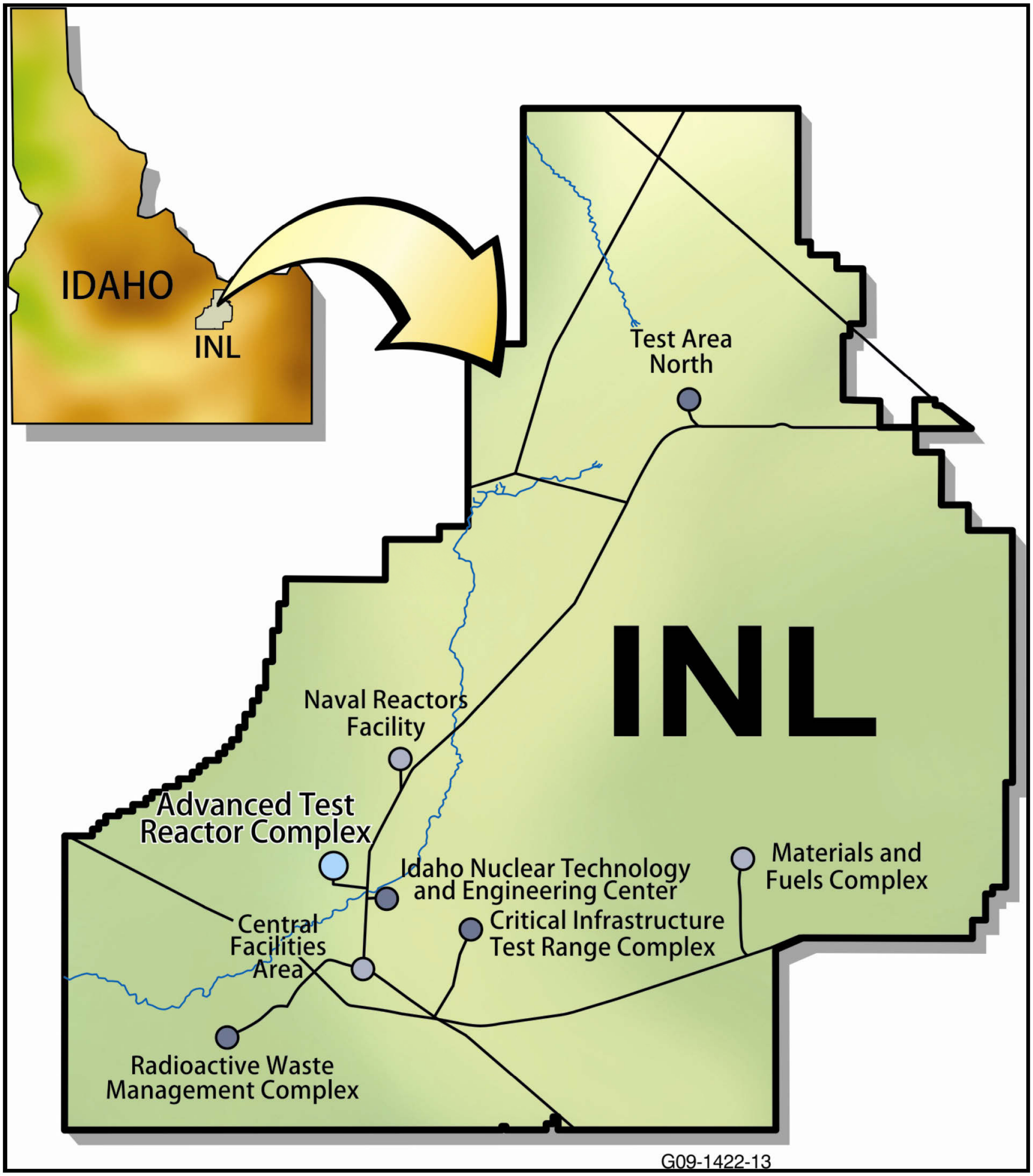

Figure 2-2. Map of the Idaho National Laboratory Site showing the location of the Advanced Test Reactor Complex and other major Site facilities.

Initial deactivation of ETR began in December 1981. The neutron startup source was removed. Radioactive water was drained from the ETR vessel, primary coolant system, water loop experiment piping and vessels, both canal sections, degassing tank and associated piping, and resin tanks. Other water systems were drained, including the secondary coolant water (including heat exchangers), utility water, the two demineralized water systems (low and high pressure), and water in heating and cooling units. The fuel in ETR, as well as irradiated fuel in the ETR storage canal, was removed and shipped to the Idaho Nuclear Technology and Engineering Center for storage and reprocessing.

Final D&D of ETR began in May of 2005 under the Idaho Cleanup Project, performed by CH2M-WG Idaho, LLC. The cleanup contract was overseen by the U.S. Department of Energy Idaho Operations Office.

2.3 Engineering Test Reactor Building

The ETR vessel was housed in a gastight building (Figure 2-3) that measured 112 × 136 ft and extended 58 ft above grade and 38 ft below grade. The reactor building (TRA-642) had four levels. The main hall, which comprised the abovegrade portions of the building, provided access to the uppermost section of the ETR vessel and the top of the ETR storage canal. The three underground levels were composed of the console level and pipe tunnel, the basement with the experiment cubicles, and a subpile room, while the lowermost level contained the control rod-access room (Figure 2-4).

Figure 2-3. The Engineering Test Reactor building (TRA-642) before demolition.

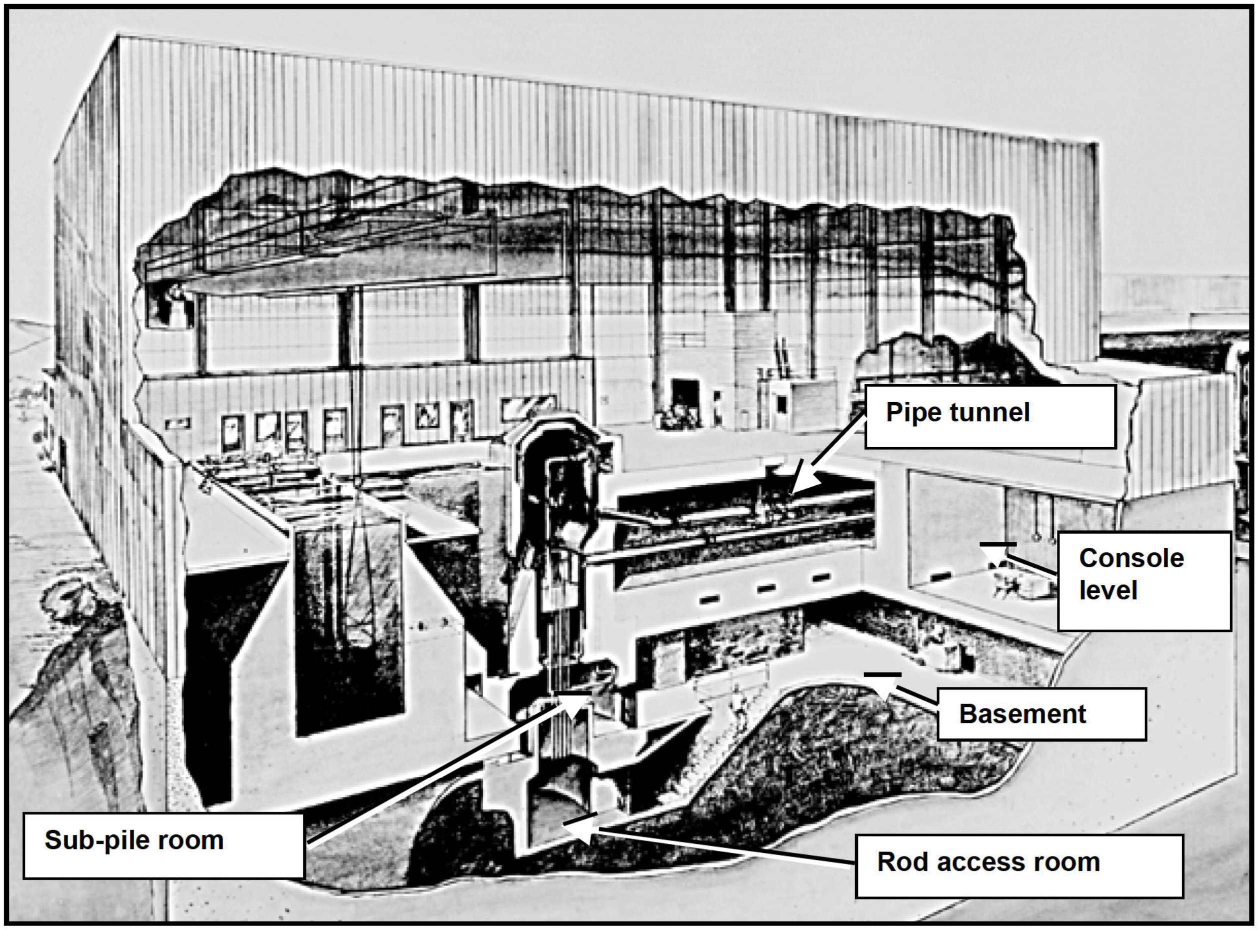

Figure 2-4. Cutaway rendering of the Engineering Test Reactor building (TRA-642), looking north.

3. DESCRIPTION OF AREAS WITHIN THE ENGINEERING TEST REACTOR BUILDING AND DECOMMISSIONING ACTIVITIES

The following sections describe the various areas within the reactor building and the activities that were performed to contribute to their final end state. Descriptions of the areas begin at the lowest level and move up to the main floor and the abovegrade structure.

3.1 Basement Level

The basement floor was 38 ft below ground surface and contained the experimental cubicles and subpile room (i.e., room below the reactor vessel). A stairway led down from the basement to the rod-access room, the lowest readily accessible space in TRA-642. Also below the basement floor, accessible by removing concrete hatch covers, were the General Electric Experimental Loop (GEEL) pipe tunnel, hot waste pit, and the warm waste pit.

3.1.1 Experiment Cubicles

The basement was subdivided into a number of cubicles (Figure 3-1). Cubicle walls and the wall surrounding the ETR vessel were composed of high-density concrete (i.e., contains magnetite). Other walls were composed of standard concrete. The cubicles contained pipes, tanks, and instruments to support the various experiments. Deactivation activities removed lead (over 735,000 lb), asbestos, and contaminated piping from the cubicle walls and shielded piping runs. All circuit boards, light bulbs, capacitors and other components potentially containing Resource Conservation and Recovery Act (RCRA) (42 USC § 6901 et seq.) -hazardous materials were removed from the instrumentation on this floor. Lead brick embedded in walls was accessed by using a diamond wire cutter to cut access holes so that the lead could be removed for disposal. The cubicles were completely stripped of all process piping, tanks, and equipment, except for the three empty air receivers that were left in place, two in secondary Cubicle L-12/M-7 and one in primary Cubicle C-7/M-13/N-14. Figures 3-2 and 3-3 show a representative cubicle, before and after stripout.

3.1.2 Subpile and Rod-Access Rooms

The subpile room was located directly below the reactor bottom head. Walls of the subpile room were composed of high-density concrete and transmitted the biological shield load to the reactor foundations, which extended to bedrock. Control rods, regulating rods, and chamber drives that passed through the subpile room to the rod-access room were all removed. The bottom head of the reactor vessel was sealed to prevent grout from leaking out during grouting of the reactor vessel.

The rod-access room was filled with grout to fill the void space under the subpile room. The subpile room was partially filled with structural concrete.

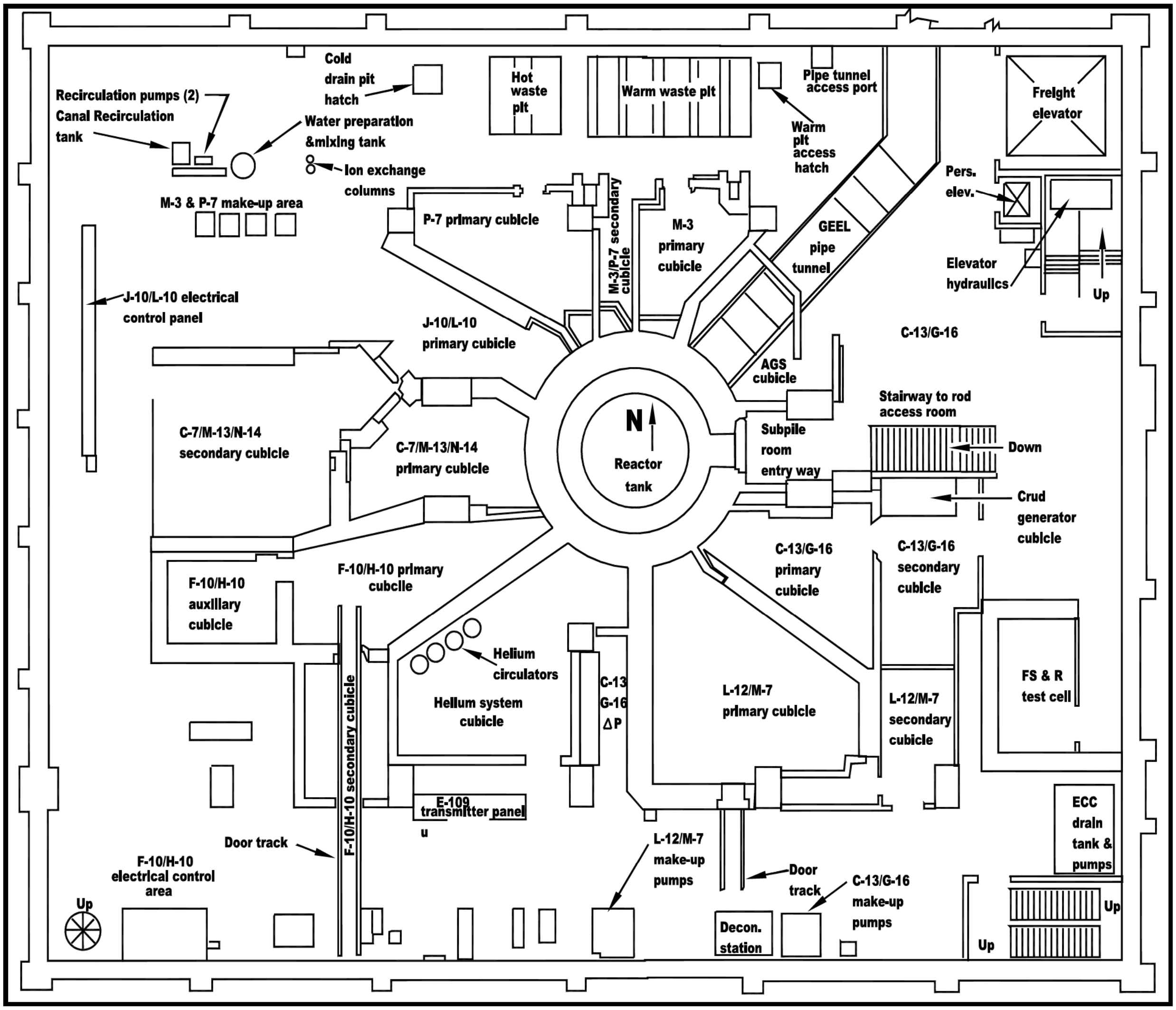

Figure 3-1. Basement floor plan of the Engineering Test Reactor building (TRA-642) showing the experiment cubicles.

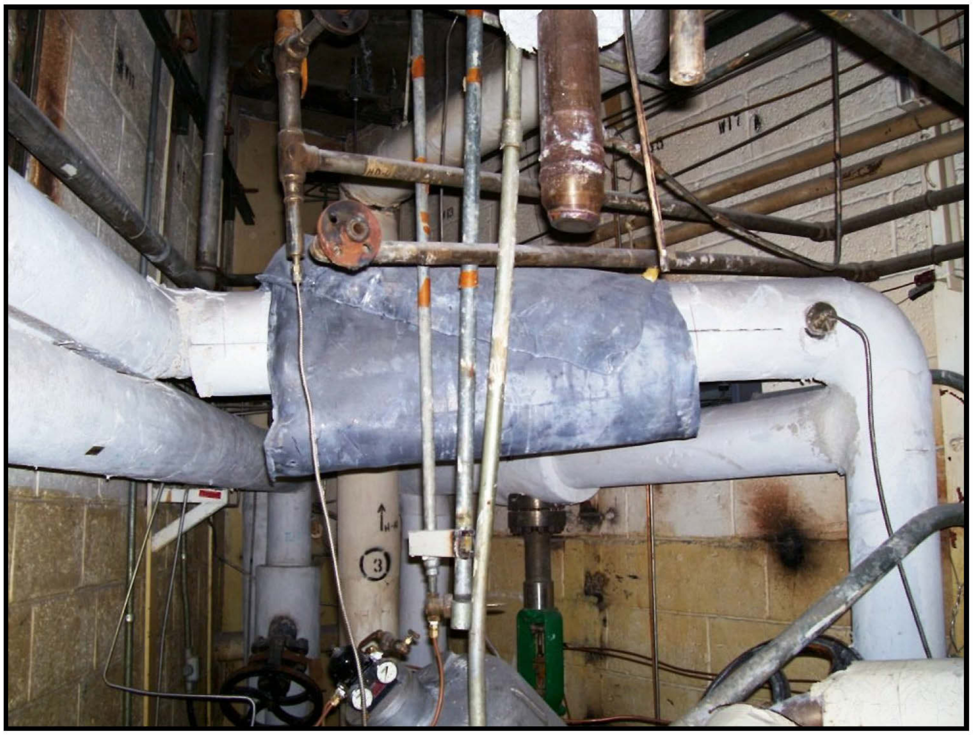

Figure 3-2. Experiment Cubicle F10/H10 prior to stripout.

Figure 3-3. Experiment Cubicle F10/H10 after stripout.

3.1.3 Warm and Hot Waste Pits

Two unlined concrete pits were built below the basement floor of the north wall of the reactor building (Figure 2-3). One of these, referred to as the hot waste pit, housed a 1,000-gal cold waste tank and a 500-gal hot waste tank. The hot waste tank was removed in 2005 as part of a Voluntary Consent Order closure (Monson 2000). The other unlined pit, referred to as the warm waste pit, held a 5,000-gal warm waste tank. These pits were located just inside the north wall of the reactor building. The remaining warm and cold waste tanks were drained of any residual liquids and inspected for residual solids (i.e., heel). No heels were found, and the tanks and vaults were abandoned in place and filled with grout.

3.1.4 General Electric Experimental Loop Tunnel

The GEEL tunnel begins beneath the reactor building basement floor, runs under the Annular Gas System cubicle, and exits the reactor building to ultimately terminate at the delay tanks. The GEEL system was designed as an integral part of the ETR Complex and consisted of three reactor inpile tubes and Loops 33, 66, and 99. The loop exhaust lines are 4, 8, and 8 in. in diameter for Loops 33, 66, and 99, respectively. These look exhaust line pipes exit the subpile room through the northwest wall and enter the GEEL cubicle. Asbestos was removed from the loop exhaust lines, lead shielding (i.e., both brick and sheets) was removed from the GEEL tunnel, and then the GEEL tunnel was filled with grout.

3.2 Console Level

The console level of the reactor building was immediately below the main floor. The floor of the console level served an additional purpose of shielding for the experimental cubicles below. Various control consoles were positioned on this floor (Figure 3-4). All circuit boards, light bulbs, capacitors and other components potentially containing RCRA-hazardous wastes were removed from the instrumentation on this floor as well as from all areas throughout the console floor, including the balcony level on the south side of the reactor. The console floor also provided access to t fallout shelters on the west side. Lead wool was removed from penetrations in the fallout shelter area, and the entire area was filled with grout.

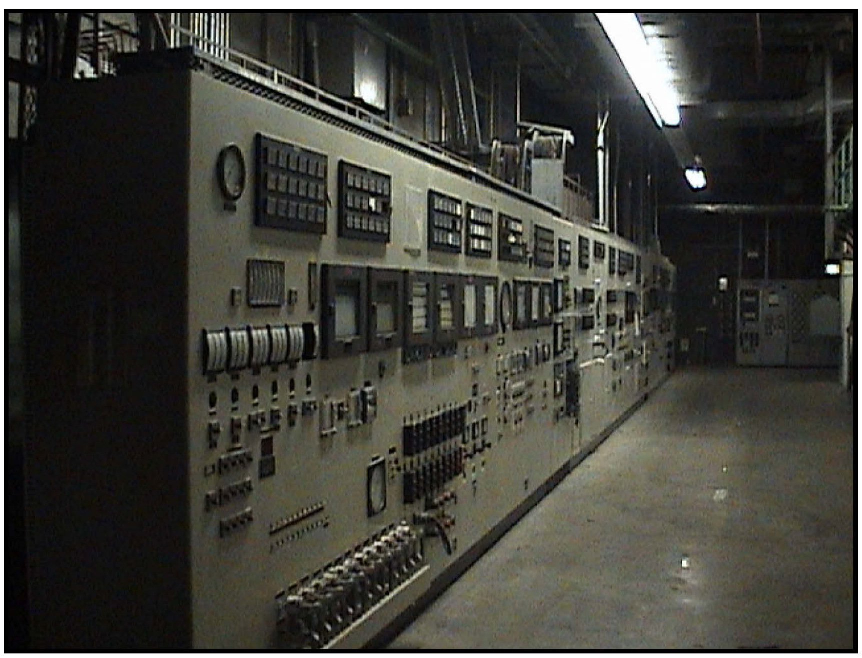

Figure 3-4. Control console on console level of the reactor building.

3.3 Demolition of the Engineering Test Reactor Building

The reactor building abovegrade structure was stripped of the corrugated siding, and the structural girders were weakened by cutting “birds’ mouths” (“V” notches). The building was then pulled over by two dump trucks and two bulldozers, using pulling straps hooked to the building girders (Figure 3-5).

Once the structure was on the ground, processors were used to size the metal girders and bridge crane to enable loading into articulated dump trucks. The trucks hauled the debris to ICDF.

Figure 3-5. Engineering Test Reactor building (TRA-642) in the process of being pulled to the ground.

Aboveground portions of the reactor building (e.g., reactor canal) (Figure 3-6) were demolished to a minimum of 3 ft below ground surface, and the resultant demolition material was used as backfill or was disposed of in accordance with the applicable disposal site waste acceptance criteria (WAC) (DOE-ID 2005). Materials left in place included inert, nonputrescible material located below ground surface (e.g., piping, equipment, electrical conduit, utility systems, and structural steel) and other residual clean materials or materials contaminated with low-level radioactive and/or chemically hazardous substances that do not present an unacceptable risk, in accordance with the RAOs for the TRA OU 2-3 ROD (DOE-ID 1997). Excavations and structures remaining below grade were backfilled to grade. Clean soil was emplaced to cover the locations of the reactor building. The final step—to grade and gravel the area—was completed in 2008 (Figure 3-7).

Figure 3-6. Removing the reactor building debris pile and leaving the Engineering Test Reactor vessel and canal visible above grade.

Figure 3-7. Previous location of the Engineering Test Reactor Complex.

4. DISPOSITION OF THE ENGINEERING TEST REACTOR VESSEL

The following section describes the ETR vessel removal and disposition activities.

4.1 Description

The ETR vessel (Figure 4-1) was a multidiameter, cylindrical vessel, approximately 36 ft in height and 12 ft in diameter at the top, reducing down to 7 ft in diameter at the bottom. Major internal components that remained in the vessel at the beginning of D&D included the control rod guide tubes, control rod sections, aluminum and beryllium reflector, grid plate, and four in-pile tubes. The vessel also contained miscellaneous fillers, adapters, and plugs. The ETR vessel, with the internal components, weighed approximately 82 tons.

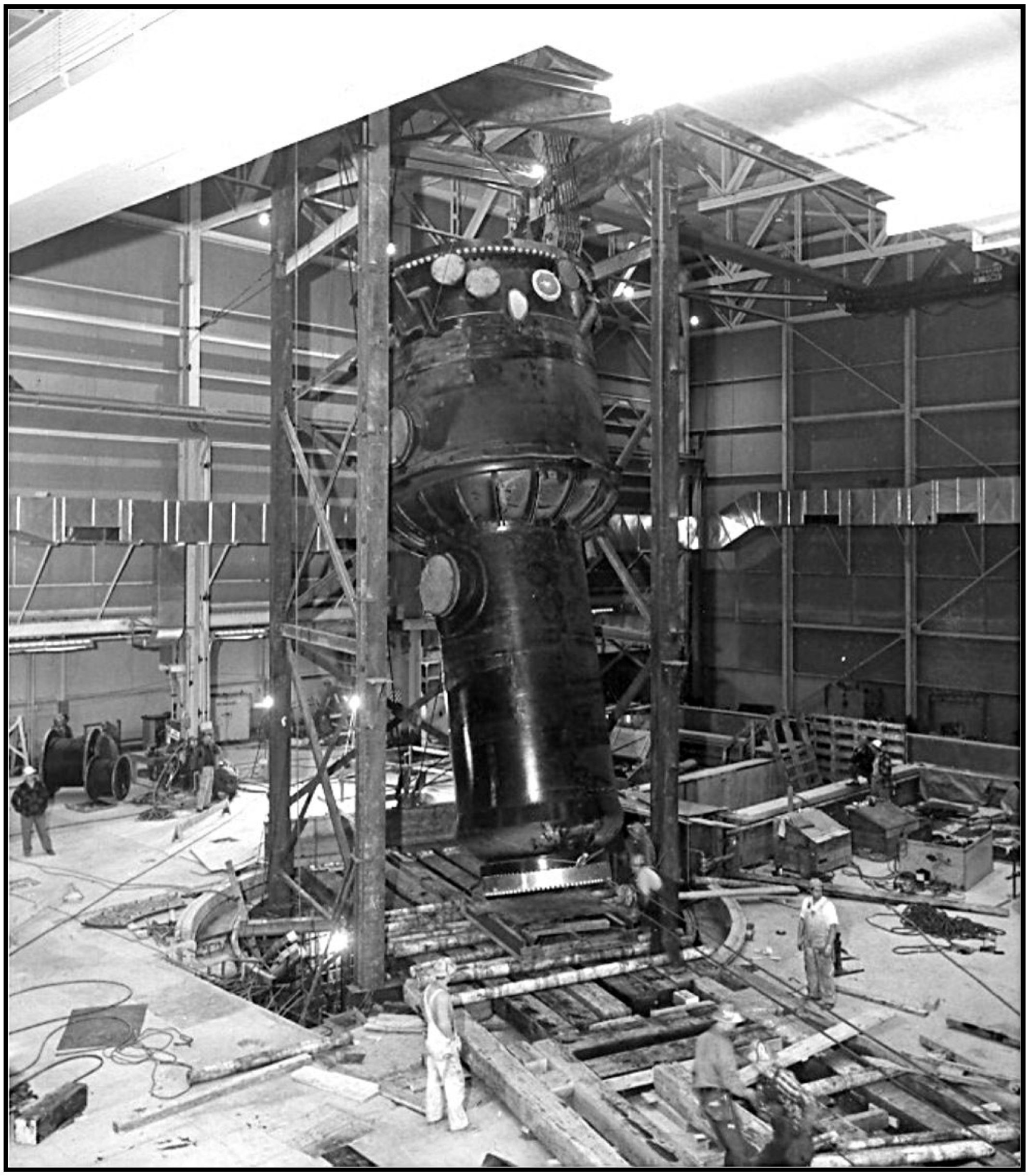

Figure 4-1. Installation of the Engineering Test Reactor vessel in 1956.

Figure 4-2. Top head of the reactor vessel after bioshield removal, showing top head and nozzles.

The reactor vessel was enclosed and supported by a high-density concrete biological shield. This shield extended the entire height of the reactor vessel and was 8 ft thick at the reactor core centerline. The high-density concrete was encased in 3/4-in. plate steel. Preparations for removing the reactor vessel included removing the biological-shield blocks that surrounded the vessel top head (Figure 4-2) and demolishing the high-density portions of the biological shielding surrounding the upper portion of the vessel, using explosive charges. Once the biological shield was fragmented with explosives, heavy equipment completed demolition of the shielding and removed the concrete and metal debris to expose the upper portion of the vessel (Figure 4-3).

Because the original cadmium control rods had been replaced with hafnium control rods, the only RCRA-hazardous waste found in the ETR vessel comprised lead contained in the reactor discharge chute cover. To retrieve this lead, the reactor vessel was filled with grout to the bottom of the discharge chute to provide shielding from the 1,100-R radiation fields caused by the irradiated reactor grid plate and core area components. Workers then entered the vessel (Figure 4-4) to retrieve the discharge chute cover by hoisting it out of the vessel, using the reactor building bridge crane.

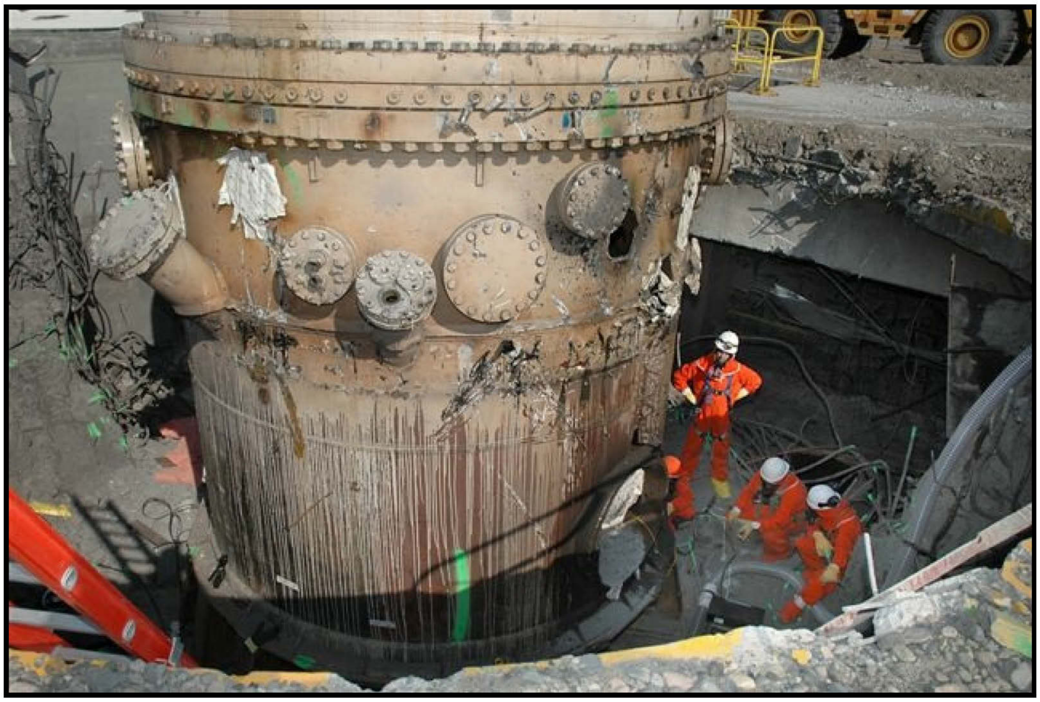

Figure 4-3. Upper section of the Engineering Test Reactor vessel after concrete and metal debris had been removed.

Figure 4-4. Deactivation and decommissioning workers, inside the Engineering Test Reactor vessel, removing a lead-containing discharge chute cover.

4.2 Removal and Disposal of the Engineering Test Reactor Vessel

In September 2009, a gantry crane was used to lift the ETR vessel from the bioshield (Figure 4-5) and place it on a multiwheeled transport trailer (Figure 4-6). The vessel was transported approximately 2.5 mi to ICDF, where it was lifted from the transport trailer, using the gantry crane, and placed in the disposal cell (Figure 4-7). The ETR vessel met the ICDF WAC and was disposed of as low-level radioactive waste. Once the vessel was placed in the ICDF disposal cell, the remaining voids in the vessel were filled with grout.

Figure 4-5. Gantry crane lifting the Engineering Test Reactor vessel for placement on the transport trailer.

Figure 4-6. The Engineering Test Reactor vessel ready for transport to the Idaho CERCLA Disposal Facility for disposal.

Figure 4-7. Placement of the Engineering Test Reactor vessel into an Idaho CERCLA Disposal Facility disposal cell.

5. OTHER ACTIVITIES CONTRIBUTING TO THE END STATE OF THE ENGINEERING TEST REACTOR BUILDING

Many deactivation activities were completed before the NTCRA was approved in the 2007 Action Memorandum (DOE-ID 2007). This section describes D&D activities that contributed to the final ETR building (TRA-642) end state.

5.1 Activities Prior to Demolition of TRA-642

The following activities were performed prior to demolition of TRA-642:

1. **Hazardous waste removal—**Hazardous wastes—such as acidic or caustic material, mercury vapor lamps and fluorescent bulbs, lead shielding, circuit boards containing lead and/or silver soldering, and waste regulated under the Toxic Substances Control Act (15 USC § 2601 et seq.) (e.g., polychlorinated biphenyl articles and equipment, such as transformers, capacitors, and fluorescent lighting ballasts that might contain polychlorinated biphenyls)—were removed and disposed of. Other hazardous and toxic wastes were removed during NTCRA activities, including those discovered during performance of these activities.

2. **Asbestos abatement activities—**Friable asbestos found in pipe and tank (i.e., vessel) insulation, fire doors, transite panels, and other potential asbestos-containing material, were removed as required under 40 CFR 61.145, "Standard for demolition and renovation."

3. **Removal of other support systems and components—**These activities included draining or emptying systems containing liquids, removing electrical cabinets, and deenergizing and isolating utilities and reconfiguring those systems (as necessary) to support continuing ATR Complex operations. In addition, chlorofluorocarbons, used as refrigerants, were removed in accordance with the requirements of Section 609 of the Clean Air Act (42 USC § 7401 et seq.).

Types of waste, volumes, and disposal locations produced during the above activities are documented in Section 9.

5.2 Voluntary Consent Order Activities

The Voluntary Consent Order program was responsible for characterizing many of the support systems associated with the ETR Complex that included RCRA-hazardous wastes. These included the waste systems (i.e., hot, warm, and cold), the ETR vessel, the primary cooling system, the experimental water loop systems, the water makeup system for the M3/P7 experimental loops, the Sodium Loop Safety Facility helium cooling system, the experimental air system, the GEEL system, and the diesel generator system. All these systems were either characterized in accordance with Hazardous Waste Management Act (HWMA) (Idaho Code § 39-4401 et seq.) and RCRA regulations or were verified as empty process or product tanks.

6. ACHIEVING REMOVAL ACTION OBJECTIVES

Implementing this removal action was consistent with the RAOs established in the TRA OU 2-3 ROD and supports the overall remediation goals established through the Federal Facility Agreement and Consent Order (DOE-ID 2001). As such, this removal action was consistent with and will contribute to the future final end state of the ATR Complex under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.). The RAOs identified in Section 1.3 were calculated 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. 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.

6.1 Radiological End-State Source Term

Of the approximately 59,000 total Curies present in TRA-642 before the removal action, fewer than 2 Ci was dispersed throughout the reactor building, and the remainder was contained in the reactor vessel. This residual inventory was found primarily within internal piping surfaces from Ni-63 contamination. However, minor fractions of the residual inventory are ubiquitous on external surfaces throughout the belowgrade components. Most of the remaining 2 Ci was removed during D&D activities, and it is estimated that approximately 0.131 Ci remains in TRA-642. Table 6-1 provides an estimate of the 2012 remaining radiological source term in TRA-642. At the end of institutional controls in the year 2095, the remaining source term would decay to about 0.008 Ci of mostly Ni-63.

Table 6-1. TRA-642 end state remaining radiological source term.

Radionuclide	End State Source Term[a] (Ci)		Radionuclide	End State Source Term (Ci)
Ag-108m	9.67E-05		Pu-238	1.49E-05
Am-241	1.91E-05		Pu-239	4.52E-05
C-14	4.66E-04		Pu-241	4.10E-04
Co-60	2.24E-02		Sr-90	3.51E-03
Cs-137	4.51E-02		Tc-99	3.39E-05
Fe-55	1.96E-02		U-233	2.50E-06
I-129	2.21E-05		U-235	2.32E-08
Ni-59	3.68E-04		U-238	2.62E-06
Ni-63	3.95E-02		Total	1.31E-01

a. These data were obtained from TBL-415.

6.2 Inventory of Nonradiological Materials End State

The inventory of nonradiological materials prior to the removal action for the reactor building and the reactor vessel was described in EDF-6225, “Engineering Test Reactor Complex Chemical Constituent Source Term.” EDF-6225 addressed the COCs (i.e., metals) associated with the ETR vessel and belowgrade portions of the ETR Complex. Removal of liquids, items that could be considered

HWMA/RCRA-hazardous waste, asbestos, and chlorofluorocarbons were removed as part of the NTCRA process and were disposed of in accordance with applicable regulatory requirements. The nonradiological COCs remaining at the end state of the ETR Complex consist of inert material (e.g., metals present in structural materials, piping, or electrical components). Table 6-2 provides a bounding estimate of the chemical constituents in the below-ground-surface remains of TRA-642.

Table 6-2. The bounding estimated chemical constituent quantities in the below-ground-surface remains of TRA-642.

Chemical Constituent	Location(s)	Use/Form	Quantity (kg)
Antimony	Concrete walls and floors	Alloy used in concrete wall lag-shield anchors	0.6
Barium (and compounds)	High-density concrete used in cubicle walls	Additive for heavy concrete used in nuclear shielding (cubicle walls), paint pigment	101,810
Chromium	Piping and other operations components throughout TRA-642 building remains	Piping, vessels, and other components constructed of stainless steel	35,420
Copper (and compounds)	Distributed throughout TRA-642 building remains	Wiring, tubing, rotors, bearings, brass and bronze components, and electrical equipment	36,840
Lead	Wall and floor anchors, piping	Small amounts of inaccessible lead wool around piping penetrations, alloy of concrete wall lag-shield anchors, pipe packing, and brass alloy	40
Manganese (and compounds)	Piping and other components throughout TRA-642 building remains	Metal alloy found in piping, vessels, and other components constructed of stainless steel	7,670
Nickel	Piping and other components throughout TRA-642 building remains	Metal alloy found in piping, vessels, and other components constructed of stainless steel	19,610
Silver (and compounds)	Electrical components	Small amounts of inaccessible electrical contacts	40
Tin	Distributed throughout TRA-642 building remains	Alloy of bronze (used in gauges, bearings, and flow indicators)	80
Zinc	Distributed throughout TRA-642 building remains	Significant alloy of brass	460

6.3 Conclusion

The RAOs identified for this removal action were achieved. The remaining radioactive and nonradioactive constituents remaining at the former location of ETR do not pose an unacceptable risk to human health or the environment. The paragraphs below discuss in more detail how the RAOs were met.

The radiological risk evaluations, as presented in the EE/CA (DOE-ID 2006), used a source term of approximately 2 Ci to calculate a human health carcinogenic risk (3×10^{-7}) from the remaining radionuclides at the ETR Complex. Using 2 Ci to calculate the risk resulted in an acceptable risk because it is less than the acceptable-risk range of 1×10^{-6} to 1×10^{-4}. The estimated total radiological source term remaining at the end state of ETR is estimated to be 0.131 Ci total activity, an order of magnitude less that the 2 Ci used to estimate the residual risk. Additionally, the residual radioactive source term mostly resides in the subsurface well below the interval 10 ft below ground surface that would be available for uptake by human or ecological receptors.

Nonradiological constituents remaining at the end state of ETR did not exceed the soil screening levels, and therefore, do not pose an unacceptable risk to human health.

The contaminant screening and risk assessment for the groundwater risk was based on the assumption that the contaminant inventory at ETR, including the reactor vessel, is left in place, and the facilities are stabilized with INL Site native soils. Based on this streamlined risk assessment, the predicted groundwater concentrations meet the required performance criteria. For groundwater, the performance criteria are to prevent migration of contaminants from the ETR facility that would cause the Snake River Plain Aquifer to exceed a cumulative carcinogenic risk level of 1×10^{-4} or applicable State of Idaho groundwater quality standards in 2095 and beyond. The maximum predicted cumulative risk is 1.6×10^{-6} or 1/62 of the performance criteria. The maximum cumulative fraction of nonradionuclide concentration to the maximum contaminant level is 0.17 or 1/6 the performance criteria of 1.

6.4 Future Actions at the Engineering Text Reactor Location

All contaminants that exceeded RAOs were removed to meet the RAOs; therefore, no institutional controls were implemented for this NTCRA. Additionally, there are no post-removal-action monitoring requirements for ETR. Details regarding institutional control requirements and post-removal-action monitoring 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).

Actions conducted under this NTCRA will be reviewed by the Idaho Department of Environmental Quality and the U.S. Environmental Protection Agency for continued protectiveness during the INL Site-wide CERCLA 5-year review process prescribed under the Federal Facility Agreement and Consent Order (DOE-ID 2001).

7. COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

Section 121 of CERCLA (42 USC § 9621) requires the responsible CERCLA implementing agency (i.e., U.S. Department of Energy) to ensure that the substantive standards of the HWMA/RCRA and other applicable, relevant, and appropriate requirements (ARARs) will be incorporated into the federal agency's design and operation of its long-term remedial actions and into its more immediate removal actions.

Table 7-1 lists the ARARs that were identified for the ETR removal action. These ARARs are a compilation and expansion of the ARARs identified in the ROD (DOE-ID 1997). At the completion of the ETR end state, all identified ARARs had been met.

The ARARs were based on several key assumptions identified in the Action Memorandum (DOE-ID 2007). Those key assumptions are listed below, including whether deviations were made from the assumption. Waste volumes and disposal locations are identified in Section 9.

- **Assumption 1—**Any residual contamination left in place will meet the RAOs established in the ROD.

  This assumption was accomplished, as discussed in Section 6, and remaining contamination—both radiological and nonradiological—was below levels that would cause an unacceptable risk to human health or the environment.

- **Assumption 2—**Liquid waste (e.g., radioactively contaminated water) is assumed to have been removed from the ETR Complex prior to initiation of the NTCRA. The liquid waste will have been previously addressed through the Voluntary Consent Order program and other regulatory activities intended to place the facility in an environmentally safe condition. Any residual liquid would be disposed of in accordance with the receiving disposal facility's WAC.

  Small quantities of residual radioactive liquids were found in tanks and lines throughout the basement levels, and liquid (reactor coolant water) was found in the inpile tubes in the reactor vessel. All water was removed and disposed of as CERCLA waste, in accordance with the WAC at the ICDF evaporation ponds.

- **Assumption 3—**The majority of lead shielding will be removed from the ETR Complex prior to initiation of the NTCRA through other regulatory activities intended to place the facility in an environmentally safe condition. However, some lead may remain following these activities that may require management under the scope of the NTCRA as CERCLA waste. Removed lead that cannot be recycled or reclaimed shall be declared a hazardous waste or mixed low-level waste and will be disposed of at an off-Site disposal facility in accordance with the disposal facility's WAC.

  All radiologically contaminated lead shielding was removed from TRA-642 and disposed of off-Site in accordance with the disposal facility's WAC. Some lead, which was found in noncontaminated areas, was recycled for use as shielding at other INL Site facilities.

Table 7-1. Summary of applicable or relevant and appropriate requirements for the Engineering Test Reactor Complex non-time-critical removal action.

Citation	Requirement/Title	ARAR Type	Comments
Clean Air Act (42 USC § 7401 et seq.) and Idaho Air Regulations			
IDAPA 58.01.01.161	"Toxic Substances"	A	Applies to any toxic substances emitting during implementation of the removal action.
40 CFR 61.92	"Standard" (<10 mrem/year)	A	Applies to waste-handling activities.
40 CFR 61.93	"Emission monitoring and test procedures"	A	Applies to waste-handling activities.
40 CFR 61.94(a)	"Compliance and reporting"	A	Applies to waste-handling activities.
40 CFR 61.145	"Standard for demolition and renovation"	A	Applies to any asbestos-containing materials removed during the decommissioning.
IDAPA 58.01.01.650 and .651	"Rules for Control of Fugitive Dust," and "General Rules"	A	Applies to waste-handling activities.
Idaho Solid Waste Facilities Act			
IDAPA 58.01.06.012	"Applicable Requirements for Tier II Facilities"	A	Applies to disposal of solid wastes at the CFA Landfill.
RCRA and Idaho HWMA			
Generator Standards			
IDAPA 58.01.05.006, "Standards Applicable to Generators of Hazardous Waste," and the following, as cited in:			
40 CFR 262.11	"Hazardous waste determination"	A	Applies to waste that would be generated during the removal action.
General Facility Standards			
IDAPA 58.01.05.008, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," and the following, as cited in:			
40 CFR 264.553	"Temporary units (TU)"	A	Waste may be treated or temporarily stored in a temporary unit prior to disposal.
40 CFR 264.554	"Staging piles"	A	Waste may be temporarily staged prior to disposal.
40 CFR 264.15	"General inspections requirements"	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to ICDF or an off-Site facility.

Table 7-1. (continued).

Citation	Requirement/Title	ARAR Type	Comments
40 CFR 264, Subpart C	"Preparedness and prevention"	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to ICDF or an off-Site facility.
40 CFR 264, Subpart D	"Contingency plan and emergency procedures"	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to ICDF or an off-Site facility.
40 CFR 264.114	"Disposal or decontamination of equipment, structures, and soils"	A	Applies to contaminated equipment used to remove, treat, or transport hazardous waste.
40 CFR 264.171–178	"Use and management of containers"	A	Applies to containers used during the removal and treatment of hazardous waste.
Land Disposal Restrictions			
IDAPA 58.01.05.011, "Land Disposal Restrictions," and the following, as cited in:			
40 CFR 268.40(a)(b)(e)	"Applicability of treatment standards"	A	Applies to hazardous waste and secondary waste if treatment is necessary to meet the disposal facility's WAC or if treatment is required before placement.
40 CFR 268.45	"Treatment standards for hazardous debris"	A	Applies to hazardous debris if treatment is necessary to meet the disposal facility's WAC or if treatment is required before placement.
40 CFR 268.48(a)	"Universal treatment standards"	A	Applies to nondebris hazardous waste and secondary waste if treatment is necessary to meet the disposal facility's WAC or if treatment is required before placement.
40 CFR 268.49	"Alternative LDR treatment standards for contaminated soil"	A	Applies to contaminated soil if treatment is necessary to meet the disposal facility's WAC or if treatment is required before placement.
IDAPA 58.01.05.016, "Standards for Universal Waste Management," and the following, as cited in:			
40 CFR 273 Subpart C	"Standards for large quantity handlers of universal waste"	A	Applies to management of universal wastes.
Idaho Groundwater Quality Rules			
IDAPA 58.01.011	"Ground water quality rule"	A	The waste-handling activities must prevent migration of contaminants from the reactor complex that would cause the Snake River Plain Aquifer groundwater to exceed applicable State of Idaho groundwater quality standards in 2095 and beyond.

Table 7-1. (continued).

Citation	Requirement/Title	ARAR Type	Comments
Toxic Substances Control Act			
40 CFR 761.79(b)(1)	"Decontamination standards and procedures: decontamination standards"	A	Applicable to decontamination of equipment with PCB contamination if PCB waste is generated.
40 CFR 761.79(c)(1) and (2)	"Decontamination standards and procedures: self-implementing decontamination procedures"	A	Applicable to decontamination of equipment with PCB contamination if PCB waste is generated.
40 CFR 761.79(d)	"Decontamination standards and procedures: decontamination solvents"	A	Applicable to decontamination of equipment used to manage PCB-contaminated waste if PCB waste is generated.
40 CFR 761.79(e)	"Decontamination standards and procedures: limitation of exposure and control of releases"	A	Applicable to decontamination activities of equipment with PCB-contaminated waste if decontamination is performed.
40 CFR 761.79(g)	"Decontamination standards and procedures: decontamination waste and residues"	A	Applicable to management of decontaminated waste and residuals from PCB-contaminated equipment if PCB waste is generated.
Department of Transportation			
49 CFR 173	"Shippers–general requirements for shipments and packagings"	A	Applicable for packaging and transportation of the ETR vessel off the INL Site.
To-Be-Considered Requirements			
DOE O 5400.5, Chapter II(1)(a,b)	"Radiation protection of the public and the environment"	TBC	Applies to the ETR Complex before, during, and after the removal action. Substantive design and construction requirements would be met to keep public exposures as low as reasonably achievable.
DOE O 435.1	"Radioactive Waste Management"	TBC	Applies to the ETR Complex before, during, and after the removal action. Substantive design and construction requirements would be met to protect workers.

Table 7-1. (continued).

Citation	Requirement/Title	ARAR Type	Comments
EPA (2006)	*Region 10 Final Policy on the Use of Institutional Controls at Federal Facilities*	TBC	Applies to residual waste following completion of the removal action.

A = applicable requirement; TBC = to be considered.

ARAR applicable or relevant and appropriate requirement
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
EPA U.S. Environmental Protection Agency
ETR Engineering Test Reactor
HWMA Hazardous Waste Management Act
ICDF Idaho CERCLA Disposal Facility
PCB polychlorinated biphenyl
RCRA Resource Conservation and Recovery Act

- **Assumption 4—**Management of CERCLA wastes generated during the removal action would be subject to meeting the ICDF WAC (DOE-ID 2005).

  All waste disposed of at ICDF from the ETR removal action met the ICDF WAC.

- **Assumption 5—**If decontamination liquids are generated, they will be disposed of at the ICDF evaporation ponds, in accordance with the approved WAC.

  Some decontamination liquids were generated as part of rinsing lines and piping and were disposed of in the ICDF evaporation ponds, in accordance with the WAC.

- **Assumption 6—**Debris generated during removal of the vessel might have paint that contains polychlorinated biphenyls (PCBs). If encountered, such waste may trigger substantive requirements of TSCA (15 USC § 2601 et seq.). Lead-contaminated paint also may be removed during recovery of the shielding lead, and this paint would be subject to the substantive requirements of RCRA-hazardous waste regulations. Nonhazardous waste would be disposed of at ICDF, unless it can be demonstrated that it is eligible for disposal as solid waste at the Central Facilities Area (CFA) Landfill Complex. PCB-containing light ballasts are planned for removal from the building prior to this removal action.

  None of the debris removed during the removal action triggered the substantive requirements of TSCA. Lead-contaminated paint was stripped from steel plating surrounding the ETR reactor vessel and was disposed of in accordance with the substantive requirements of RCRA-hazardous waste regulations. Nonhazardous/nonradiologically contaminated wastes generated as part of the removal action were disposed of at either the CFA Landfill Complex or the Idaho CERCLA Demolition Waste Landfill, which is located in the former location of the INTEC percolation ponds.

- **Assumption 7—**Asbestos-containing material, which is both friable and nonfriable, may be encountered incidental to performance of the NTCRA. Friable or regulated asbestos-containing material is subject to specific asbestos regulations and would be acceptable for disposal at the ICDF and/or, if not radiologically contaminated, at the CFA Asbestos Landfill. Regulated asbestos will be removed and disposed of as required by 40 CFR 61.150, "Standard for waste disposal for manufacturing, fabricating, demolition, renovation, and spraying operations." Undisturbed asbestos or asbestos found in high-radiation, high-contamination, and/or inaccessible locations deeper than 3 ft below ground surface may be left in place.

  Noncontaminated asbestos-containing material was removed from TRA-642 and disposed of at the CFA Landfill. Contaminated asbestos was disposed of at ICDF. There was no known asbestos left in TRA-642 at the end state.

- **Assumption 8—**Mercury located in mercury fluorescent lamps is planned for removal prior to this removal action under other regulatory activities intended to place the facility in an environmentally safe condition, as would the mercury-containing electrical switches and lights. No mercury is expected to be present in the building substructure at the start of the removal action.

  Mercury was discovered in instrumentation in the cubicle area in the basement of TRA-642. Section 9 identifies the volume and disposal location of the mercury removed.

8. PROJECT COSTS

As part of the EE/CA (DOE-ID 2006) preparation, detailed cost estimates were prepared that included a cost for the selected remedy, Alternative 3. That estimate identified D&D costs at $6,442,243. Actual costs for completion of the removal action were $6,085,329. The actual cost is within the threshold of +50% to -30% of the estimated cost identified in the EE/CA.

9. WASTE GENERATION

Wastes removed from TRA-642 during the NTCRA and other activities that contributed to the final end state were dispositioned in compliance with applicable disposal requirements. Table 9-1 lists volumes of waste generated and the disposal locations. Figure 9-1 shows members of the D&D crew responsible for bringing the ETR Complex to a successful end state.

Table 9-1. Waste generation and disposal location.

Waste Type	Volume		Disposal Location
Mixed low-level waste	173 m^3	6,109 ft^3	Energy Solutions and Nevada Test Site (currently named the Nevada National Security Site)
CERCLA solid waste	4,321 m^3	152,595 ft^3	ICDF Landfill
CERCLA liquid waste	41.2 m^3	10,881 gal	ICDF Evaporation Pond
PCBs	3.29 m^3	116.2 ft^3	Clean Harbors
Elemental mercury	0.02 m^3	5.28 gal	Clean Harbors
Batteries	0.12 m^3	4.24 ft^3	Clean Harbors
Universal waste light bulbs	1.88 m^3	66.4 ft^3	Clean Harbors
RCRA-hazardous scrap (including circuit boards)	4.02 m^3	142 ft^3	Clean Harbors
Miscellaneous RCRA-hazardous (paint chips and peel away materials)	0.02 m^3	0.7 ft^3	Clean Harbors
Used oil	0.13 m^3	4.6 ft^3	Clean Harbors
Contaminated elemental mercury	0.8 m^3	210.3 gal	Materials and Energy Corporation
Noncontaminated asbestos	130.06 m^3	4,892 ft^3	CFA Landfill

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
CFA Central Facilities Area
ICDF Idaho CERCLA Disposal Facility
PCB polychlorinated biphenyl
RCRA Resource Conservation and Recovery Act

Figure 9-1. The deactivation and decommissioning crew that brought the Engineering Test Reactor Complex to the final end state.

10. LESSONS LEARNED

In order to satisfy regulatory agreements, the ETR vessel was removed for disposal. The vessel was encased in a biological shield constructed of high-density concrete strengthened by many layers of iron rebar. Additionally, numerous pipes and conduits ran through the biological shield. The purpose of this shield was to prevent radiation from reaching workers on the main floor and lower levels of the building.

The standard demolition practice for removing concrete is to pound on it with a hydraulic hammer-head attachment to a track-hoe until the concrete is fractured and can be removed with a backhoe bucket or front-end loader. Because of the tensile strength of the high-density concrete and large volume of rebar and other metal in the bioshield, hydraulic hammering was considered to be problematic.

A professional explosive demolition company was contracted to fracture the bioshield with explosive charges. The demolition company used a rock drill to core holes into the bioshield for placement of the explosive charges. Once the charges were detonated (Figure 10-1), the concrete was successfully fractured, and much of the rebar mat, metal pipes, and conduits were severed (Figure 10-2).

Using explosives saved many hours of hammering on the bioshield and saved what would have been extensive wear to the track-hoe as well as to the operators who would have had to man the cab of the track-hoe. Explosives can be an efficient, safe, and cost-effective tool for demolition of nuclear buildings and structures.

Figure 10-1. Stop-action photograph of the explosive demolition of the Engineering Test Reactor bioshield.

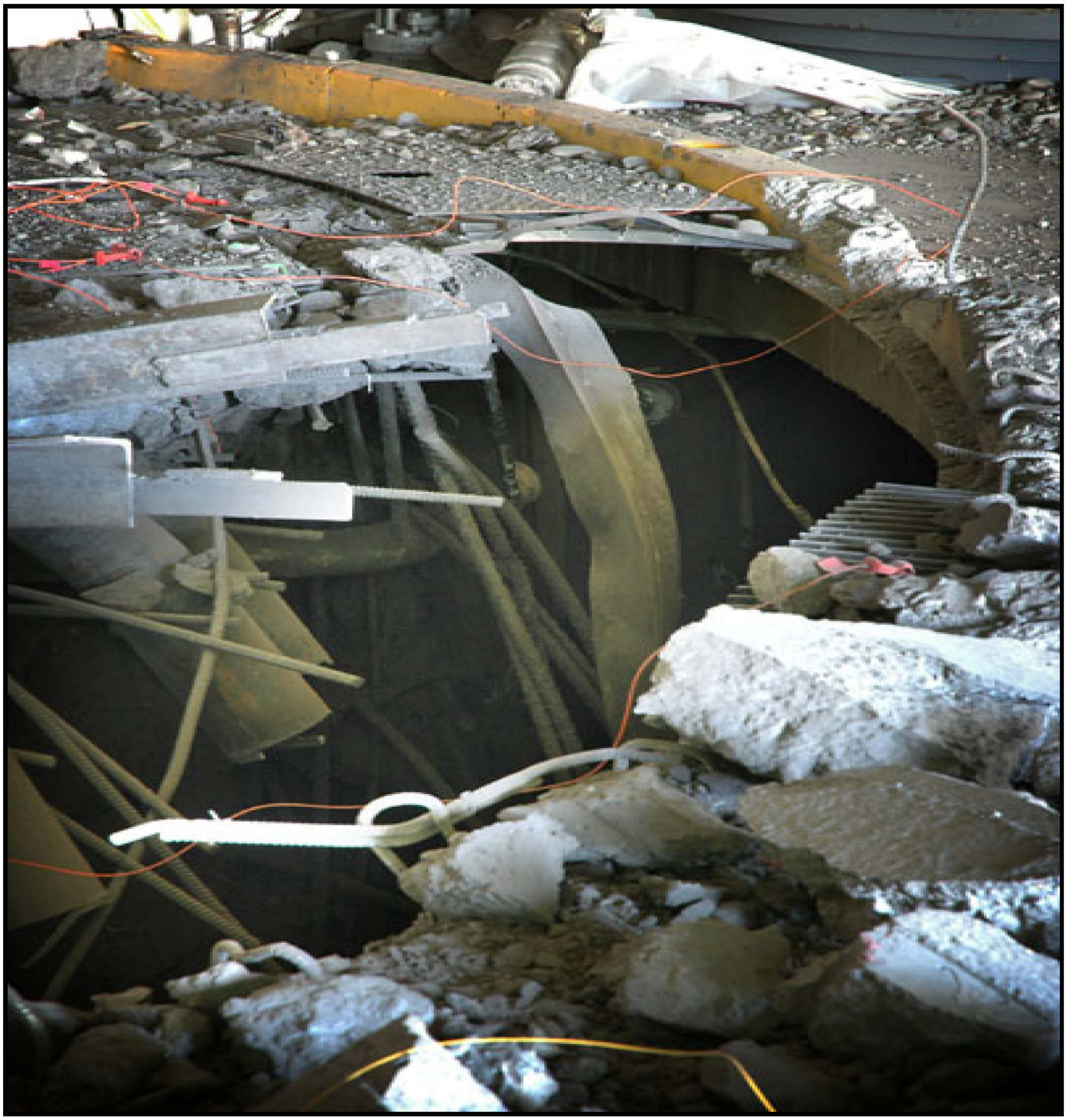

Figure 10-2. Result of explosive fracturing of the Engineering Test Reactor bioshield.

11. REFERENCES

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