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Engineering Evaluation/Cost Analysis for Decommissioning of the TRA-632 Hot Cells

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ABSTRACT

Preparation of this engineering evaluation/cost analysis (EE/CA) is consistent with the joint U.S. Department of Energy and U.S. Environmental Protection Agency *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), which establishes the CERCLA non-time-critical removal action process as an approach for decommissioning. This removal action is consistent with the remedial action objectives of the *Final Record of Decision, Test Reactor Area Operable Unit 2-13, Idaho National Engineering and Environmental Laboratory* and the *Explanation of Significant Differences to the Record of Decision for Test Reactor Area Operable Unit 2-13, Idaho National Engineering and Environmental Laboratory.*

This EE/CA evaluates the TRA-632 Hot Cells building and the three hot cells contained in the building. The TRA-632 building concrete floor slab containing the hot waste drains, piping under the floor slab, and associated soil contamination, if found, are not part of this EE/CA. The drains and piping are ancillary to the TRA-630 Catch Tank System and have been identified as part of the Voluntary Consent Order Action Plan (VCO-5.8.d). Soil contamination, if found under the slab, will be addressed under the future TRA-632 Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan and/or the CERCLA program.

This EE/CA evaluates alternatives and recommends a preferred alternative for the final end state of the TRA-632 building and hot cells.

The recommended removal action alternative is Alternative 3, complete removal of the TRA-632 building and hot cells and disposal of the wastes at the Idaho CERCLA Disposal Facility in accordance with the facility waste acceptance criteria.

EXECUTIVE SUMMARY

This engineering evaluation/cost analysis (EE/CA) was prepared to support a determination for the final end state of the TRA-632 Hot Cells, which includes the building and the three hot cells contained in the building. The process to accomplish this determination is to perform a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) non-time-critical removal action (NTCRA). The approach satisfies environmental review requirements and provides for stakeholder involvement while supplying a framework for selecting the decommissioning alternative. The approach also establishes an Administrative Record for documentation of the removal action.

In keeping with the joint U.S. Department of Energy and U.S. Environmental Protection Agency *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act* (DOE and EPA 1995), this EE/CA was developed in accordance with CERCLA as amended by Public Law 99-499, "Superfund Amendments and Reauthorization Act of 1986," and in accordance with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300). The removal action objectives of this NTCRA are also consistent with the *Final Record of Decision, Test Reactor Area Operable Unit 2-13, Idaho National Engineering and Environmental Laboratory* (DOE-ID 1997) and the *Explanation of Significant Differences to the Record of Decision for Test Reactor Area Operable Unit 2-13, Idaho National Engineering and Environmental Laboratory* (DOE-ID 2000). The objectives support the overall remediation goals established through the Federal Facility Agreement and Consent Order (DOE-ID 1991) and the Department of Energy goal of reducing the "risk footprint" to as practicable extent as possible in consideration of as-low-as-reasonably-achievable principles governing radiological exposure to decommissioning personnel, safe engineering standards, Idaho CERCLA Disposal Facility (ICDF) waste acceptance criteria, and desired CERCLA site end states.

The purpose of this EE/CA is to evaluate alternatives and recommend a preferred alternative for the final end state of the TRA-632 building and hot cells. Three alternatives are evaluated in this EE/CA:

> Alternative 1: No Action. The no action alternative assumes no decommissioning or demolition would be conducted at TRA-632 on the building or hot cells and there would be no further surveillance or maintenance at this facility. The no action alternative offers no reduction in toxicity, mobility, or volume of contaminants.
>
> The no action alternative is presented for comparative purposes only. The assumption is that the sum of identified radiological contamination, if not properly contained or controlled, will be released to the environment, with a potential risk to receptors (current and future workers, hypothetical future residents, flora, and fauna). This assumption does not reflect the Department of Energy mandate to monitor, maintain, and mitigate potential or actual releases from any facility or site to ensure protection of the public health or the environment.
>
> Alternative 2: No Action: Continued Surveillance and Maintenance. Under Alternative 2, there would be no action except surveillance and maintenance. This alternative also offers no reduction in toxicity or volume of contaminants, but it does provide more protection from mobilization of the contaminants to the environment than Alternative 1.

Alternative 3 (Recommended Alternative): Removal of the TRA-632 building and hot cells. Alternative 3 fully removes the building down to the slab and removes the three hot cells contained in the building. Wastes from the removal are disposed of at the ICDF. All above-slab portions of the hot cells will either be removed whole or sectioned prior to hoisting onto heavy-haul trailers for transport to the disposal facility. To reduce the spread of radioactive contamination during removal, the internal volume of the cells may be grouted. Under Alternative 3, no hazardous substances would remain above the slab at the hot cell location.

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ACRONYMS

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ATR	Advanced Test Reactor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRMP	Cultural Resources Management Plan
D&D	decommissioning and demolition
DEQ	Idaho Department of Environmental Quality
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
EBSL	ecologically based screening level
EE/CA	engineering evaluation/cost analysis
EPA	Environmental Protection Agency
ETR	Engineering Test Reactor
FFA/CO	Federal Facility Agreement and Consent Order
HWMA	Hazardous Waste Management Act
ICDF	Idaho CERCLA Disposal Facility
ICP	Idaho Cleanup Project
INL	Idaho National Laboratory
MTR	Materials Test Reactor
NHPA	National Historic Preservation Act
NTCRA	non-time-critical removal action
OU	operable unit
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
TRA	Test Reactor Area
VCO	Voluntary Consent Order
WAC	waste acceptance criteria

Engineering Evaluation/Cost Analysis for Decommissioning of the TRA-632 Hot Cells

1. INTRODUCTION

The engineering evaluation/cost analysis (EE/CA) process is used to determine the end state of the TRA-632 building and the three hot cells contained in the building. TRA-632 is located at the Idaho National Laboratory (INL) Advanced Test Reactor (ATR) Complex. The EE/CA is intended to satisfy environmental review requirements while providing a framework for selecting the end state and satisfying Administrative Record requirements for documentation of the removal action. This EE/CA identifies removal action proposed alternatives and analyzes these alternatives for effectiveness, implementability, and cost. Following the issuance of this EE/CA for public comment and consideration of comments received during the public review period, U.S. Department of Energy (DOE) will issue, with concurrence from the Idaho Department of Environmental Quality (DEQ) and U.S. Environmental Protection Agency (EPA), an Action Memorandum documenting the selected alternative.

This EE/CA was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.) as amended by the "Superfund Amendments and Reauthorization Act of 1986" (Public Law 99-499) and in accordance with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300). The removal action objectives of this non-time-critical removal action (NTCRA) are also consistent with the *Final Record of Decision Test Reactor Area Operable Unit 2-13, Idaho National Engineering and Environmental Laboratory* (DOE-ID 1997) and the *Explanation of Significant Differences to the Record of Decision Test Reactor Area Operable Unit 2-13, Idaho National Engineering and Environmental Laboratory* (DOE-ID 2000) that provide the basis for cleanup levels at the ATR Complex, formerly the Test Reactor Area (TRA). The objectives support the overall remediation goals established through the Federal Facility Agreement and Consent Order (FFA/CO) (DOE-ID 1991) and the DOE goal of reducing the "risk footprint" to as practicable extent as possible in consideration of as-low-as-reasonably-achievable (ALARA) principles governing radiological exposure to decommissioning personnel, safe engineering standards, Idaho CERCLA Disposal Facility (ICDF) waste acceptance criteria (WAC), and desired CERCLA site end states.

This NTCRA is also consistent with the joint DOE and EPA *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act* (DOE and EPA 1995), which establishes the CERCLA NTCRA process as the preferred approach for decommissioning surplus DOE facilities. Under this policy, a NTCRA may be taken when DOE determines that the action will *prevent, minimize, stabilize, or eliminate* a risk to human health and/or the environment. When DOE determines that a CERCLA NTCRA is necessary, DOE is authorized to evaluate, select, and implement the removal action that DOE determines is most appropriate to address the potential risk posed by the release or threat of release. This action is taken in accordance with applicable authorities and in conjunction with EPA and the State of Idaho, pursuant to Section 5.3 of the FFA/CO (DOE-ID 1991).

Performance of this removal action will place the facilities in a configuration that is protective of human health and the environment. Without decommissioning the TRA-632 Hot Cells, a potential threat of release of hazardous substances exists, and, without action, adverse threats to human health and the environment eventually could occur. As the lead agency, DOE has determined that a removal action is an appropriate means to accomplish the final end state and achieve environmental review requirements.

Both the DEQ and the EPA concur that a NTCRA is warranted to place the TRA-632 building and hot cells in a final configuration that is protective of human health and the environment.

This EE/CA will become part of the INL Administrative Record. Documentation supporting this EE/CA, such as the engineering design files, will also be included in the Administrative Record. The INL Administrative Record is on the Internet at http://ar.inel.gov/ and is available to the public at the following locations:

Albertsons Library	INL Technical Library
Boise State University	DOE Public Reading Room
1910 University Drive	1776 Science Center Drive
Boise, ID 83725	Idaho Falls, ID 83415
(208) 426-1625	(208) 526-1185

1.1 Purpose and Scope

This engineering EE/CA evaluates the TRA-632 Hot Cells building and the three hot cells contained in the building. The TRA-632 building concrete floor slab containing the hot waste drains, piping under the floor slab, and associated soil contamination, if found, are not part of this EE/CA. The drains and piping are ancillary to the TRA-630 Catch Tank System and have been identified as part of the Hazardous Waste Management Act (HWMA)/Resource Conservation and Recovery Act (RCRA) Voluntary Consent Order (VCO) Action Plan (VCO-5.8.d). Soil contamination, if found under the floor slab, will be addressed under the future TRA-632 HWMA/RCRA Closure Plan and/or the CERCLA program.

The *Engineering Evaluation/Cost Analysis for General Decommissioning Activities under the Idaho Cleanup Project* (DOE-ID 2006a) allows "decommissioning preparatory activities" to go forth in the "more substantial and significant facilities," such as the hot cells, but specifically excludes end-state decisions. Therefore, this EE/CA will determine the final end state of the hot cells while some decommissioning preparatory activities are going forward in accordance with the General Decommissioning EE/CA. These decommissioning preparatory activities involve routine waste management practices, such as removal of lead, polychlorinated biphenyls (PCBs), and asbestos from the hot cells. Some nonstructural strip out of the TRA-632 building may also be conducted. Additionally, a HWMA/RCRA satellite accumulation area is currently located within Hot Cell #3. Any hazardous waste located in the satellite accumulation area will be managed outside of the scope of this NTCRA.

2. SITE CHARACTERIZATION

This section provides summary background information and a description of the INL Site and the TRA-632 building and hot cells.

2.1 Site Description and Background

2.1.1 Idaho National Laboratory Site and Idaho Cleanup Project

The INL Site, managed by DOE, is located 51 km (32 mi) west of Idaho Falls, Idaho. It occupies 2,305 km^2 (890 mi^2) of the northeastern portion of the Eastern Snake River Plain. In 1949, the U.S. Atomic Energy Commission established the INL Site, which was called the National Reactor Testing Station at that time. Its purpose was to conduct nuclear energy research and related activities. It was redesignated the Idaho National Engineering Laboratory in 1974 and then the Idaho National Engineering and Environmental Laboratory in 1997. In 2005, to better focus the laboratory's missions, DOE established the Idaho Cleanup Project (ICP) to bring the environmental management mission to completion and redesignated the Site as the INL Site to better reflect the laboratory's new research directions.

U.S. Department of Energy Idaho Operations Office (DOE-ID) controls all land within the INL Site. Public access is restricted to public highways, sponsored tours, special-use permits, and the Experimental Breeder Reactor I National Historic Landmark. In addition, DOE-ID is cognizant of the Shoshone-Bannock tribal members' need for access to areas on the INL Site for cultural and religious purposes.

The INL Site is located primarily in Butte County; however, it also occupies portions of Bingham, Bonneville, Clark, and Jefferson counties. The 2000 census indicated the following populations for cities in the region: Idaho Falls–50,730; Pocatello–51,466; Blackfoot–10,419; Arco–1,026; and Atomic City–25.

Surface water flows on the INL Site consist mainly of three streams draining intermountain valleys to the north and northwest of the INL Site: (1) the Big Lost River, (2) the Little Lost River, and (3) Birch Creek. All of the channels terminate on the INL Site. Flows from Birch Creek and the Little Lost River seldom reach the INL Site because of irrigation withdrawals upstream. The Big Lost River and Birch Creek may flow onto the INL Site before the irrigation season or during high-water years, but the terminal reaches are usually dry. In those few wetter years when the Big Lost River carries water to the end of its channel, the water sinks into the ground.

The physical characteristics, climate, flora and fauna, demography, and cultural resources of the INL Site and ATR Complex are further described in the Record of Decision (ROD) (DOE-ID 1997).

2.1.2 TRA-632 Hot Cells Location

The TRA-632 Hot Cells are located at the ATR Complex in the west-central portion of the INL (Figure 2-1). The hot cells are located in the TRA-632 building (Figure 2-2 and Figure 2-3) in the south-central portion of the ATR Complex.

Figure 2-1. Location of the ATR Complex on the INL Site.

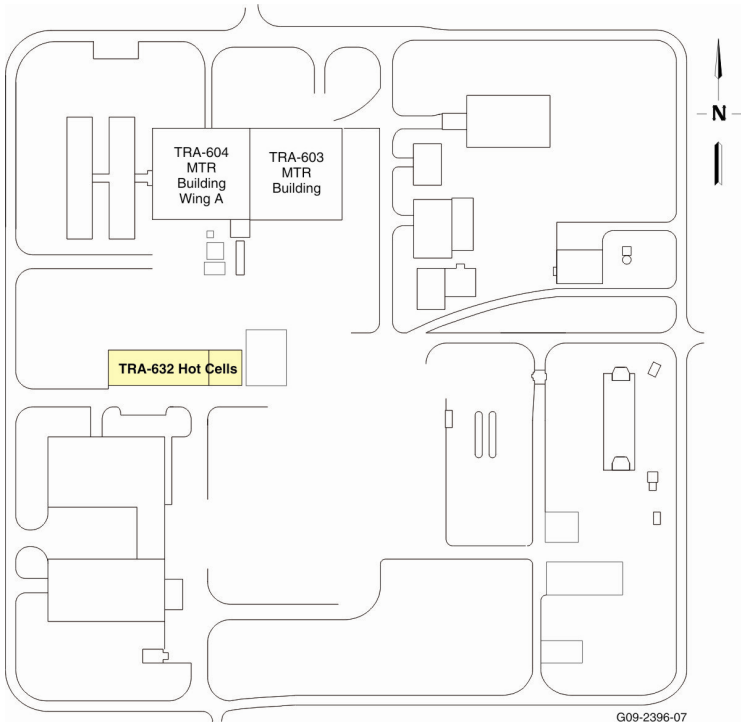

Figure 2-2. Location of TRA-632 Hot Cells building at the ATR Complex.

Figure 2-3. TRA-632 building.

2.1.3 TRA-632 Hot Cells Description

The hot cells were designed and built to assemble/disassemble nuclear test reactor components and for the examination of materials exposed to neutron bombardment. Processes that were contained in the hot cells included gamma scanning, photography, and optical metallography. Machine equipment included lathes, power saws, grinders, and welders, which were available in the cells for preparation or processing of materials. There are also stainless steel tables and other fixtures in the cells. The hot cells were also used to produce radioisotopes, including cobalt-60 and iridium-192, for radiography and other medical procedures, such as cancer treatment. The TRA-632 building contains the three hot cells (Figure 2-4).

2.1.3.1 Hot Cell #1. Hot Cell #1 (Figure 2-5) is located on the east side of the TRA-632 building and was constructed in 1952 to support the operation of the Materials Test Reactor. Personnel access to Hot Cell #1 is from the south side of the cell. There are five master-slave manipulators located on the north wall of the cell above the three viewing windows. There are two periscopes used for magnified viewing of materials in the cell and also one window on the west end of the cell. Figure 2-5 is a photo of this cell.

Hot Cell #1 was designed for examining/processing high-dose-rate irradiated materials. To provide adequate shielding for this purpose, the walls were constructed of nominally 4-ft-thick high-density concrete, lined on the interior with 1/4-in. painted carbon steel plate. With the exception of the westernmost viewing window, the cell windows are filled with zinc bromide. To improve clarity, the westernmost window was converted to a lead glass window filled with mineral oil. Table 2-1 presents the dimensions and estimated weight of the cell.

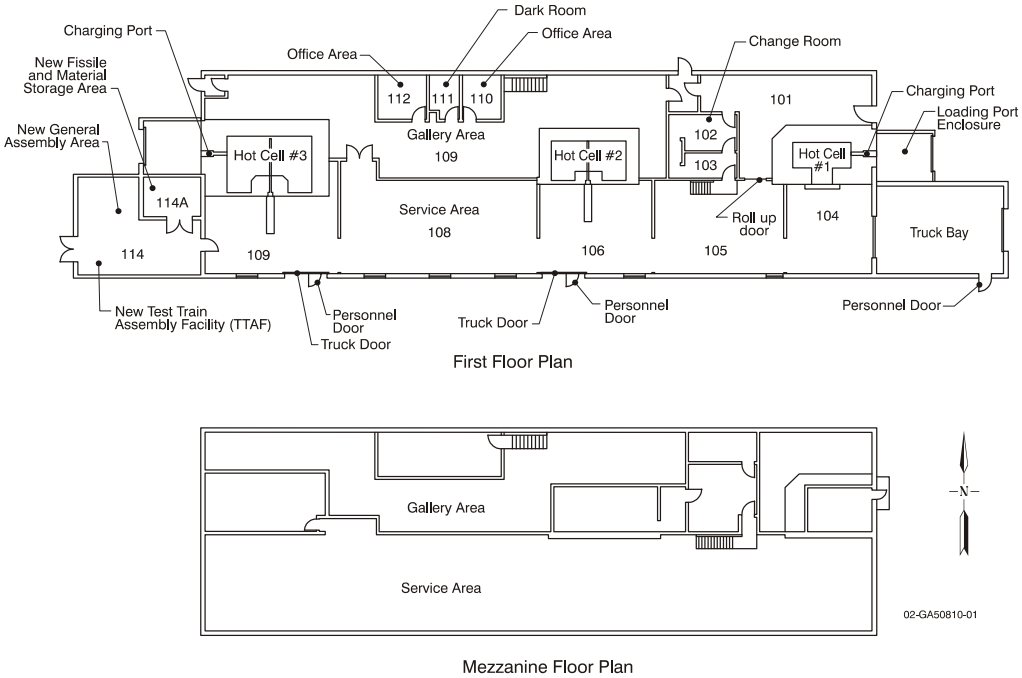

Figure 2-4. TRA-632 Hot Cell building floor plan.

Figure 2-5. Photo of Hot Cell #1.

Table 2-1. Physical description of Hot Cell #1.

	Width	Depth	Height	Concrete Type
Interior dimensions	14 ft	6 ft 6 in.	12 ft 10 in.	
Walls and ceiling thickness	4 ft	4 ft	2 ft 6 in.	High density
Outside dimensions	22 ft	14 ft 6 in.	15 ft 4 in.	
	Ungrouted	If grouted prior to removing		
Estimated weight	280 tons	367 tons		

2.1.3.2 Hot Cell #2. Hot Cell #2 (Figure 2-6), also known as the "light cell," was completed in 1960 to increase the capacity of the facility and is located in the center of the TRA-632 building. There are four viewing windows and master-slave manipulators on the north wall and one viewing window on the west wall. The east wall contains a metallography cave that allows visual examination of specimens under magnification to approximately 2,000X. The west wall contains a scanning microscope cave and provides for examining specimens at a resolution of approximately 1 micron.

Hot Cell #2 was used for handling/storing lower-dose-rate materials. The walls of this cell are formed from ordinary concrete 2 ft 9 in. thick. The floor and lower walls (to 6 ft above the floor) are lined with 1/4-in. carbon steel plate. This cell could be divided into two equal-sized subcells by means of a 6-in.-thick motor-driven steel door, which slides horizontally on a floor track. There are two pairs of 9-in.-thick steel swing doors on the south wall of the cave, which were used to access the cave. Table 2-2 presents the dimensions and estimated weight of the cell.

Figure 2-6. Photo of Hot Cell #2.

Table 2-2. Physical description of Hot Cell #2.

	Width	Depth	Height	Concrete Type
Interior dimensions	18 ft 6 in.	8 ft	13 ft	
Walls and ceiling thickness	2 ft 9 in.	2 ft 9 in.	2 ft	Normal density
Outside dimensions	24 ft	13 ft 6 in.	15 ft	
	Ungrouted	If grouted prior to removing		
Estimated weight	238 tons	330 tons		

2.1.3.3 Hot Cell #3. Like Hot Cell #2, Hot Cell #3 (Figure 2-7) was completed in 1960 to increase the capacity of the facility. Hot Cell #3 is located on the west end of TRA-632 building. Hot Cell #3 was also used for processing/storing high-dose-rate materials. The south and west walls were constructed of 5-ft-6-in.-thick ordinary concrete, and the remaining walls were constructed of 4-ft-thick high-density concrete. The floor and lower walls (to 6 ft above the floor) are lined with ¼-in. carbon steel plate. There are four viewing windows on the north wall and one viewing window on the east wall. This cell could also be divided into east and west subcells using a 6-in.-thick motor-driven steel door. Access to this cell is through two pairs of 18-in.-thick steel swing doors. Table 2-3 presents the dimensions and estimated weight of the cell.

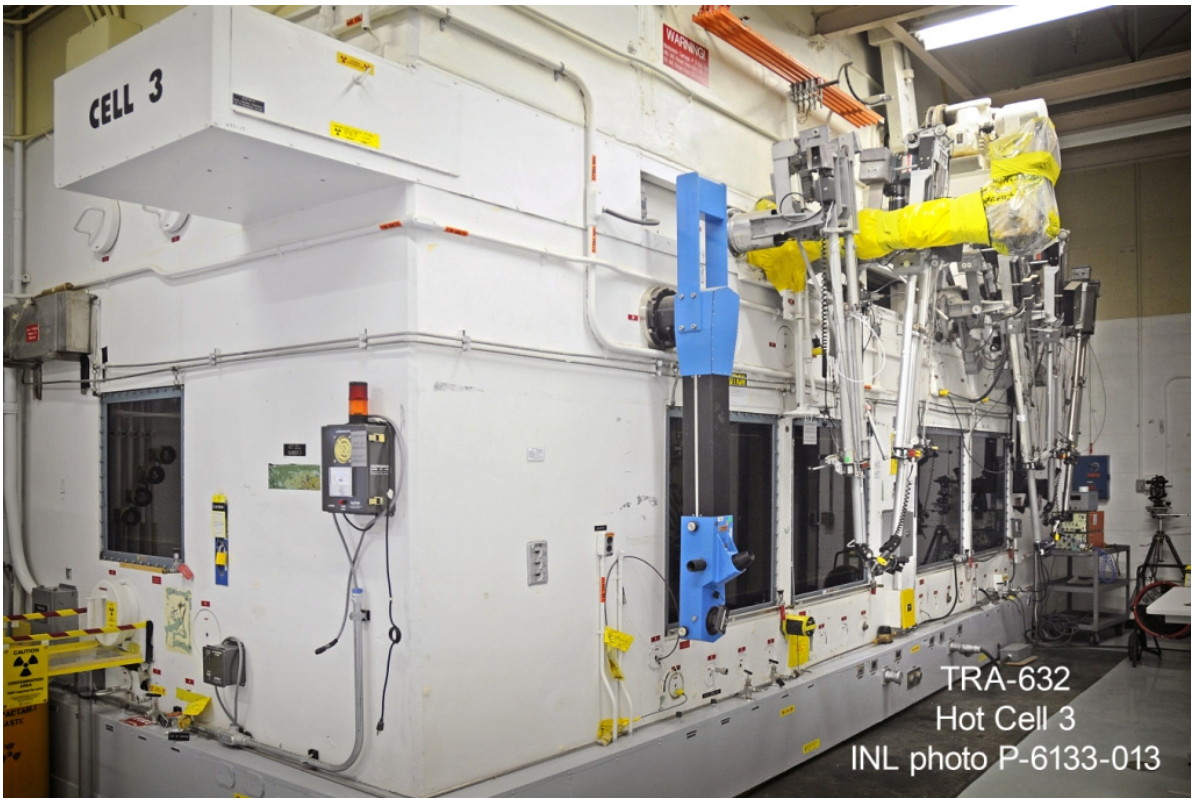

Figure 2-7. Photo of Hot Cell #3.

Table 2-3. Physical description of Hot Cell #3.

	Width	Depth	Height	Concrete Type
Interior dimensions	20 ft 6 in.	10 ft	12 ft 10 in.	
Walls and ceiling thickness	5 ft 6 in. south and west 4 ft north and east		3 ft 6 in.	Normal density and high density
Outside dimensions	30 ft	19 ft 6 in.	16 ft 4 in.	

	Ungrouted	If grouted prior to removing
Estimated weight	519 tons	716 tons

2.2 Other Closure/Cleanup Activities at the ATR Complex

Closure/cleanup activities have taken place and will continue at the ATR Complex under numerous programs and regulatory authorities. The following sections briefly describe those activities.

2.2.1 Comprehensive Environmental Response, Compensation, and Liability Act Activities at the ATR Complex

The CERCLA Final ROD for TRA (now ATR Complex) Operable Unit (OU) 2-13 (DOE-ID 1997) and *Explanation of Significant Differences to the Record of Decision for Test Reactor Area Operable Unit 2-13* (DOE-ID 2000) selected a remedy for the cleanup of identified contaminated soil at the ATR Complex. Remedies also were selected for the warm waste pond, perched water system, chemical waste pond, and sewage leach pond. Remedial actions specified by the ROD (DOE-ID 1997) have been completed at Waste Area Group 2 and as required under CERCLA (42 USC § 9601 et seq.). Whenever contamination is left in place, institutional controls have been implemented for residual contaminants left in place at concentrations that would not allow for unrestricted use or access. Fifteen sites at the ATR Complex were found to require institutional controls to ensure adequate protection of human health and the environment. The Explanation of Significant Differences (DOE-ID 2000) discusses, in detail, implementation, maintenance, and monitoring of institutional controls at each ATR Complex site.

Groundwater monitoring under CERCLA has been ongoing at the ATR Complex in accordance with the requirements of the OU 2-12 and OU 2-13 RODs (DOE-ID 1992, 1997). On October 7, 1991, the EPA designated the Snake River Plain Aquifer a sole-source aquifer under the Safe Drinking Water Act (42 USC § 300f et seq.). Although the Snake River Plain Aquifer and perched water beneath the ATR Complex are listed as No Further Action sites, they are monitored extensively, because changes in these sites could be indicative of the effectiveness of the remedies in place at the OU 2-13 sites or could indicate the occurrence of a new release.

2.2.2 Other Non-Time-Critical Removal Action Activities at ATR Complex

Decommissioning and demolition (D&D) of the Engineering Test Reactor (ETR) Complex buildings is complete in accordance with a CERCLA NTCRA as documented in the *Action Memorandum for Decommissioning the Engineering Test Reactor Complex under the Idaho Cleanup Project* (DOE-ID 2007a). D&D of the Materials Test Reactor (MTR) reactor building is ongoing and nearly complete. The end state for the MTR reactor building vessel is described in the *Action Memorandum for the Materials Test Reactor Facility End State and Vessel Disposal* (DOE-ID 2007b). The ETR Complex was immediately adjacent and to the south of the TRA-632 Hot Cells building and the MTR Complex is immediately to the north. Similar to the recommended alternative in this EE/CA, the selected alternative

under the ETR and MTR Action Memoranda was for removal of abovegrade buildings and structures and disposal of the radioactive contaminated wastes and reactor vessels at the ICDF.

Other facilities at the ATR Complex have completed D&D under the General Decommissioning Action Memorandum (DOE-ID 2006a). These facilities include the TRA-626 Maintenance Storage Building, TRA-657 MTR Plug Storage Building, TRA-635 Materials Receiving and Lab Area, and TRA-661 Radiochemistry Laboratories. Buildings and structures that will undergo D&D in the future in accordance with the General Decommissioning Action Memorandum (DOE-ID 2006a) include the TRA-712 Retention Basins and their associated structures.

2.2.3 Voluntary Consent Order Activities

VCO actions are being implemented to ensure compliance with HWMA/RCRA regulations. The VCO is a consent order between DOE-ID and DEQ to address potential legacy HWMA/RCRA waste issues. VCO characterization actions have determined that the radioactive drain network located beneath Building TRA-632 contains HWMA/RCRA residual waste and is therefore subject to further VCO actions. The drains and piping are ancillary to the TRA-630 Catch Tank System, have been identified as part of the VCO Action Plan (VCO-5.8.d), and are outside the scope of this EE/CA. Soil contamination, if found under the slab, will be addressed under the future TRA-632 HWMA/RCRA Closure Plan and/or the CERCLA program.

3. TRA-632 HOT CELLS RADIOLOGICAL INVENTORIES

The radiological characterizations of TRA-632 have been completed and documented in facility documentation (TBL-181). The methodologies used in these documents to obtain the source term values were reviewed and found to be reasonable and/or conservative. Additionally, facility operations personnel were interviewed to verify that no operations in the facility have occurred since the inventories were calculated that would result in an increase in the facility source term beyond that already documented. Table 3-1 presents the radiological inventory found in the facility documentation and is only reduced for materials known to have been removed from the facility and for radioactive decay.

Cell #1 has had extensive decontamination performed. These decontamination activities involved CO_2 pellet blasting followed by vacuuming of cell surfaces. Based on the nature of work activities performed in the cell (acidic processes that etched the contamination into the cell surfaces), the relatively low reduction in cell dose rate following decontamination, and the decontamination activities performed (vacuuming of surfaces), the cell source term is due to fixed contamination with an insignificant contribution by loose contamination.

Cell #2 is protected as a radiological contamination area. The majority of floor, equipment, and table surfaces have loose contamination at levels that are <2.25E-3 $\mu Ci/cm^2$. Based on the measured dose rates in the cell, the cell contains fixed contamination at levels that exceed 5 $\mu Ci/cm^2$. Thus, the source term in Cell #2 is due to fixed contamination with loose contamination making an insignificant contribution.

The radiological source term for Cell #3 in Table 3-1 is documented in facility radiological documentation as being due to waste items (activated materials, Cell #1 decon waste, etc.) remaining in the cell. Three waste items remaining in the cell (a stove pipe, inline filters, and a 1-gal paint can) are currently being managed as RCRA mixed waste. A final waste determination on the materials in the satellite accumulation area has not been completed, so, to preserve conservatism in the risk assessment, the items in the satellite accumulation area are included in Table 3-1 as part of the Cell #3 radiological inventory.

The cell ventilation system source term is derived from radiological surveys performed on the Cell #1 high-efficiency particulate air bank during the removal of the filters. The results of these surveys indicated relatively low levels of loose contamination (1.35E-04 $\mu Ci/cm^2$). Based on the source term determined from the measured dose rates, the fixed contamination levels are as high as 19 $\mu Ci/cm^2$. Thus, it can be concluded that the ventilation source term is due to fixed contamination with an insignificant contribution by loose contamination.

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. The estimated current radionuclide inventory for Hot Cell #1 is 227 Ci, Hot Cell #2 is 0.505 Ci, Hot Cell #3 is 1,570 Ci, and cell ventilation system is 2 Ci. Therefore, the total current source term for the hot cells is estimated to be 1,800 Ci. The current source term was then decayed until the year 2095 to provide the source term that will be incorporated in the risk evaluations presented in Section 4.

Table 3-1. TRA-632 Hot Cells radiological source term.

Nuclide	Cell 1 (Ci)	Cell 2 (Ci)	Cell 3 (Ci)	Cell Ventilation (Ci)	2009 Cell Source Term (Ci)	2095 Cell Source Term (Ci)
Ac-225	0	0	0	0	0	1.744E-10
Ac-227	0	0	0	0	0	5.907E-09
Ac-228	0	0	0	0	0	2.898E-17
Am-241	1.66E-05	8.79E-03	7.31E-05	1.43E-04	9.0232E-03	1.285E-02
Am-243	0	0	1.39E-04	5.05E-09	1.3893E-04	1.378E-04
At-217	0	0	0	0	0	1.744E-10
Be-10	0	0	4.92E-10	1.78E-14	4.9202E-10	4.920E-10
Bi-210	0	0	0	0	0	8.614E-10
Bi-211	0	0	0	0	0	5.895E-09
Bi-213	0	0	0	0	0	1.744E-10
Bi-214	0	0	0	0	0	1.684E-09
C-14	1.60E-03	0	1.14E-03	1.34E-05	2.7514E-03	2.723E-03
Ce-141	0	0	4.09E-21	0	4.0901E-21	0
Cl-36	0	0	2.51E-10	9.10E-15	2.5101E-10	2.510E-10
Cm-242	0	4.24E-05	0	6.86E-07	4.3054E-05	0
Cm-244	0	1.15E-03	0	1.87E-05	1.1706E-03	4.354E-05
Co-58	0	0	1.66E-08	2.51E-10	1.6847E-08	0
Co-60	2.18E+02	5.13E-02	1.27E+03	1.87E+00	1.4915E+03	1.829E-02
Cr-51	0	0	4.61E-01	0	4.6139E-01	0
Cs-137	3.89E-01	1.59E-01	4.61E-01	5.83E-03	1.0153E+00	1.408E-01
Eu-152	3.37E+00	3.03E-02	7.54E-01	2.86E-02	4.1788E+00	5.218E-02
Eu-154	3.90E+00	3.03E-02	8.60E-01	3.29E-02	4.8259E+00	5.517E-03
Eu-155	1.01E+00	5.51E-03	2.26E-01	8.49E-03	1.2471E+00	7.524E-06
Fe-55	4.11E-01	0	2.66E+02	1.39E-02	2.6617E+02	6.868E-08
Fe-59	0	0	1.20E-15	2.10E-15	3.3057E-15	0
Fr-221	0	0	0	0	0	1.744E-10
Fr-223	0	0	0	0	0	8.152E-11
Gd-152	0	0	0	0	0	1.418E-13
Gd-153	0	0	1.56E-04	4.60E-08	1.5631E-04	0
H-3	0	0	8.57E-05	1.21E-13	8.5690E-05	6.679E-07
Hf-175	0	0	2.25E-14	0	2.2456E-14	0
Hf-181	0	0	3.72E-16	0	3.7211E-16	0
I-129	0	9.19E-07	0	1.49E-08	9.3413E-07	9.341E-07
Ir-192	0	0	1.29E-09	4.50E-11	1.3380E-09	0
Mn-54	0	0	9.68E-01	3.96E-05	9.6810E-01	0
Nb-95	0	0	8.33E-20	0	8.3346E-20	0
Ni-59	0	0	7.48E-02	2.72E-06	7.4799E-02	7.474E-02

Table 3-1. (continued).

Nuclide	Cell 1 (Ci)	Cell 2 (Ci)	Cell 3 (Ci)	Cell Ventilation (Ci)	2009 Cell Source Term (Ci)	2095 Cell Source Term (Ci)
Ni-63	8.58E-02	0	2.70E+01	1.71E-03	2.7092E+01	1.494E+01
Np-237	0	1.14E-04	0	1.84E-06	1.1546E-04	1.158E-04
Np-239	0	0	0	0	0	1.378E-04
P-32	0	0	9.03E-49	0	9.0287E-49	1.293E-11
Pa-231	0	0	0	0	0	8.970E-09
Pa-233	0	0	0	0	0	1.158E-04
Pa-234	0	0	0	0	0	3.947E-08
Pa-234m	0	0	0	0	0	2.467E-05
Pb-209	0	0	0	0	0	1.744E-10
Pb-210	0	0	0	0	0	8.619E-10
Pb-211	0	0	0	0	0	5.895E-09
Pb-214	0	0	0	0	0	1.684E-09
Po-210	0	0	0	0	0	8.475E-10
Po-211	0	0	0	0	0	1.609E-11
Po-213	0	0	0	0	0	1.706E-10
Po-214	0	0	0	0	0	1.683E-09
Po-215	0	0	0	0	0	5.895E-09
Po-218	0	0	0	0	0	1.684E-09
Pu-238	7.23E-05	3.98E-02	3.19E-04	6.46E-04	4.0866E-02	2.072E-02
Pu-239	4.15E-05	4.95E-03	6.63E-04	8.05E-05	5.7358E-03	5.722E-03
Pu-240	0	6.41E-03	0	1.04E-04	6.5146E-03	6.459E-03
Pu-241	0	1.67E-01	0	2.70E-03	1.6931E-01	2.697E-03
Ra-223	0	0	0	0	0	5.895E-09
Ra-225	0	0	0	0	0	1.746E-10
Ra-226	0	0	0	0	0	1.684E-09
Rn-219	0	0	0	0	0	5.895E-09
Rn-222	0	0	0	0	0	1.684E-09
S-35	0	0	2.89E-08	0	2.8872E-08	0
Sb-124	0	0	8.15E-11	9.83E-15	8.1510E-11	0
Se-75	0	0	8.24E-06	0	8.2423E-06	0
Si-32	0	0	1.55E-11	5.66E-16	1.5493E-11	1.293E-11
Sr-89	0	0	6.80E-16	0	6.7971E-16	0
Sr-90	1.66E-04	0	3.52E-03	1.52E-06	3.6872E-03	4.587E-04
Ta-182	0	0	1.72E-10	0	1.7171E-10	0
Tb-160	0	0	1.55E-12	0	1.5538E-12	0
Tc-99	0	5.86E-04	0	9.48E-06	5.9513E-04	5.950E-04
Th-227	0	0	0	0	0	5.818E-09
Th-229	0	0	0	0	0	1.748E-10

Table 3-1. (continued).

Nuclide	Cell 1 (Ci)	Cell 2 (Ci)	Cell 3 (Ci)	Cell Ventilation (Ci)	2009 Cell Source Term (Ci)	2095 Cell Source Term (Ci)
Th-230	0	0	0	0	0	9.245E-08
Th-231	0	0	0	0	0	4.935E-06
Th-234	0	0	0	0	0	2.467E-05
Tl-207	0	0	0	0	0	5.879E-09
Tl-209	0	0	0	0	0	3.767E-12
U-233	0	0	0	0	0	4.323E-08
U-234	0	1.14E-04	0	1.84E-06	1.1546E-04	1.227E-04
U-235	0	4.86E-06	0	7.86E-08	4.9343E-06	4.935E-06
U-236	0	0	0	0	0	1.652E-08
U-237	0	0	0	0	0	6.616E-08
U-238	0	2.43E-05	0	3.93E-07	2.4671E-05	2.467E-05
W-185	0	0	4.57E-09	0	4.5673E-09	0
Zn-65	0	0	1.01E-03	2.93E-07	1.0125E-03	0
Totals	2.27E+02	5.05E-01	1.57E+03	1.96E+00	1.80E+03	1.53E+01
Totals	227 Ci	0.5 Ci	1,570 Ci	2 Ci	1,800 Ci	15.3 Ci

4. RISK ASSESSMENTS

This section provides the methodologies and results of the Human Health Risk Assessment, Groundwater Risk Assessment, and Ecological Risk Evaluation. Under Alternative 1, the radiological constituents are available for uptake and are used in the analysis to determine if an unacceptable risk to human health or the environment is possible.

Nonradiological constituents were determined, by qualitative means, to pose no unacceptable risk to a future residential receptor, groundwater, or an ecological receptor. The hot cells are constructed of concrete, stainless steel, and carbon steel, which contain such constituents as manganese, nickel, chrome-III, and iron. These materials have been shown not to pose an unacceptable risk in assessments where larger quantities and higher soil concentrations of these materials were present than what is present above the slab at TRA-632. For example, the ETR Complex (DOE-ID 2006b) contained many times the mass of these materials than the TRA-632 Hot Cells but still did not pose an unacceptable risk to human or ecological receptors.

4.1 Human Health Risk Assessment

For the purpose of this EE/CA, of the three alternatives presented in Section 6, only Alternative 1 requires a quantitative evaluation for risk. It is assumed that, in Alternative 2, the facility surveillance and maintenance would keep the facility from degrading to a point where contaminants would be available for uptake by a future resident. DOE-ID would continue to control access to the facility; therefore, there would be no risk to the public. For Alternative 3, all contaminants would be removed from above the floor slab at TRA-632 Hot Cells, and there would be no unacceptable risk above background to a potential future resident. Risks from potential contamination that may be discovered beneath the hot cell floor slab upon completion of the hot cell decommissioning will be evaluated in the future under either the VCO or a future CERCLA response action or both.

Under Alternative 1, it is conservatively assumed that the TRA-632 building, hot cells, and the underlying concrete slab would deteriorate to rubble over the next 85 years (to the year 2095, the date used by the ICP CERCLA program to establish remediation goals) and contamination be made available to a future residential family. This family would build a house on the rubble (assumed depth of 6 in.), live there for 30 years, including 6 years of childhood, and be exposed to radiation via external exposure, soil ingestion, and inhalation of fugitive dust.

The human health risk assessment is a two-step process. The first step is screening the soil contamination source term against soil screening levels, such as preliminary remediation goals (PRGs) for radionuclides (EPA 2009a). PRGs are based on a 1E-06 carcinogenic risk, i.e., for a given radionuclide, a soil concentration at or below its PRG indicates risk from that radionuclide is less than 1E-06. A carcinogenic risk of 1E-06 is equivalent to one additional fatal or nonfatal cancer risk in one million above that normally seen in the population. The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300) considers a risk less than 1E-04 (one excess cancer risk in 10,000 people) to be within the acceptable carcinogenic risk range; a 1E-06 risk threshold for screening ensures an adequate margin for retaining potentially significant risk contributors. The second step of the risk assessment is to perform risk calculations on those radionuclides not screened out in the first step.

4.1.1 Source Term Screening

The original source term used for this screening is presented in Table 3-1 above. The entire source term is assumed spread throughout a volume of soil 0.5 ft (0.15 m) thick and the area of the hot cells (1,228 ft^2 [114 m^2]). Soil contamination concentrations were calculated by conservatively using only the

total area of the three hot cells. This was done because most of the radiological contaminants in TRA-632 building reside in the hot cells. As stated above, the contamination would be assumed to be 0.5 ft (0.15 m) deep, and the density of this contaminated layer would be 2 g/cm^3.

The source term was decayed for 85 years and the daughter products of the radionuclide decay were included in the screening calculations. Soil screening levels were calculated for the soil ingestion, produce ingestion, inhalation, and external exposure pathways. The minimum soil screening level among these was selected for each radionuclide for comparison to calculated soil concentrations. The decayed soil concentrations, minimum screening values, and screening results are presented in Appendix A.

4.1.2 Risk Analysis

Risk assessment was performed on the radionuclides not screened out by soil screening levels. The EPA's Risk Calculator on the Risk Assessment Information System web site (http://rais.ornl.gov/cgi-bin/prg/RISK_search?select=rad) (EPA 2009b) was used to calculate risk. The calculator uses equations from the *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A, B, C, D, E & F)* (EPA 1989) and *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (EPA 1988). The calculated risk represents the incremental probability of an individual developing cancer over a lifetime. For calculations of exposure to soil, the Boise climatic zone and a site area of 0.5 acres were selected. For all other parameters, default values were used.

4.1.3 Human Health Risk Results

The acceptable risk level at the INL Site for CERCLA removal actions objectives is 1E-04, based on (1) conservative approaches in risk assessment that tend to overestimate the risk, (2) remote location of the INL Site, and (3) use of 1E-04 in previous risk management decisions across the INL Site. The total risk to a future resident from the no action alternative, at 1.21E-01, would exceed the acceptable level (bold font in Table 4-1).

Table 4-1. Risks, as calculated by EPA's risk calculator, to a future resident from Alternative 1.

Radionuclide	2095 Soil Concentration (pCi/g)	Ingestion of Soil Risk	Inhalation of Soil Particulates	External Exposure to Soil Risk	Total Soil Risk
Am-241	3.75E+02	1.00E-04	4.95E-07	9.06E-05	1.91E-04
Am-243	4.03E+00	1.10E-06	5.23E-09	3.42E-06	4.52E-06
C-14	7.96E+01	2.79E-07	2.70E-11	5.58E-09	2.85E-07
Co-60	5.34E+02	6.74E-06	2.29E-10	1.46E-02	1.47E-02
Cs-137+D	4.11E+03	1.62E-04	1.70E-09	6.55E-02	6.57E-02
Eu-152	1.52E+03	1.57E-05	3.37E-09	3.59E-02	3.59E-02
Eu-154	1.61E+02	2.22E-06	3.42E-10	3.23E-03	3.23E-03
Ni-59	2.18E+03	2.01E-06	4.89E-11	0.00E+00	2.01E-06
Ni-63	4.36E+05	8.84E-04	3.09E-08	0.00E+00	8.84E-04
Np-237+D	3.38E+00	6.90E-07	2.88E-09	2.41E-05	2.48E-05
Po-213	4.99E-06	0	0	0.00E+00	0

Table 4-1. (continued).

Radionuclide	2095 Soil Concentration (pCi/g)	Ingestion of Soil Risk	Inhalation of Soil Particulates	External Exposure to Soil Risk	Total Soil Risk
Pu-238	6.05E+02	1.85E-04	8.71E-07	3.49E-07	1.86E-04
Pu-239	1.67E+02	5.81E-05	2.68E-07	2.99E-07	5.86E-05
Pu-240	1.89E+02	6.59E-05	3.02E-07	1.18E-07	6.63E-05
Rn-222	4.92E-05	0	0	3.86E-16	3.86E-16
Sr-90+D	1.34E+01	1.74E-06	5.21E-11	1.68E-06	3.42E-06
Tc-99	1.74E+01	1.68E-07	1.18E-11	1.27E-08	1.81E-07
	Total risk	1.49E-03	1.98E-06	1.19E-01	**1.21E-01**

4.2 TRA-632 Hot Cells Groundwater Pathway Risk Assessment

A groundwater risk assessment was performed to support evaluation of Alternative 1—No Action for the TRA-632 Hot Cells. No groundwater risk assessment was performed for the complete removal alternative because there would be no contaminants remaining above the TRA-632 floor slab. This section summarizes the methodology and results from the groundwater risk assessment.

Based on the characterization activities, the pre-demolition inventory for the hot cells consisted of 48 individual radionuclides. Of these, 23 radionuclides have radioactive decay half-lives of less than 5 years and were eliminated from consideration as groundwater pathway contaminants of interest because they will essentially decay in place. A conservative screening-level risk assessment was used to evaluate the 25 radionuclides with radioactive decay half-lives greater than 5 years. A subsurface flow and transport code (GWSCREEN, Version 2.5 [Rood 2003]) was used for the screening-level risk assessment.

The hot cells source area is conservatively assumed to be the sum of the areas of the three hot cells. In reality, contaminants from the hot cells will mix in a much larger area, which will significantly dilute radionuclide concentrations in the aquifer. The estimated source thickness is based on the assumption that the contaminant inventory in the hot cells is left in place and the facilities degrade over the next 85 years to the point where they crumble to the ground. It is assumed that the rubble and contamination are lying on top of the ground surface to a depth of 6 in.

To the extent possible, the subsurface and transport conceptual model used for the risk assessment was developed based on the Track 2 guidance document (DOE-ID 1994) flow and transport assumptions. The Track 2 process was developed at the INL and for INL sites in order to consistently calculate screening-level conservative groundwater risk values for different sites. This conceptual model was used for the TRA-632 Hot Cells evaluation in order to ensure that the risk assessment is conservative.

The CERCLA groundwater performance criteria of contaminant concentrations in the Snake River Plain Aquifer are defined as less than or equal to a cumulative carcinogenic risk of 1E-04 and/or meeting the applicable State of Idaho groundwater quality standards in 2095 and beyond. The results of this screening-level conservative groundwater risk assessment (Table 4-2) indicate the peak cumulative risk is 3E-06 (about 6,000 years in the future). Pu-239 and Pu-240 account for the majority of this total risk. The predicted maximum groundwater concentrations for the radionuclides of concern were compared to the State of Idaho maximum contaminant levels for select radionuclides. All predicted maximum groundwater concentrations are less than the maximum contaminant levels.

Table 4-2. Groundwater radionuclide risk results for the TRA-632 Hot Cells.

Radionuclide	Calendar Year of Maximum Risk (year)	Screening-Level Groundwater Pathway Maximum Risk
Am-241 (Np-237)[a]	4,261	3.1E-09
Am-243	8,104	3.0E-08
Be-10	70,690	5.4E-15
C-14	2,092	1.4E-07
Cl-36	2,065	2.9E-14
Cm-244 (Pu-240)[a]	8,104	6.5E-10
Co-60	4,969	0.0E+00
Cs-137	147,110	0.0E+00
Eu-152	100,699	0.0E+00
Eu-154	100,699	0.0E+00
H-3	2,065	6.6E-12
I-129	2,065	4.7E-09
Ni-59	29,515	6.2E-08
Ni-63	29,515	0.0E+00
Np-237	4,261	2.0E-07
Pu-238 (U-234)[a]	3,712	3.2E-08
Pu-239	8,104	1.8E-06
Pu-240	8,104	1.3E-06
Pu-241(Np-237)[a]	4,261	2.0E-09
Si-32	11,673	3.3E-34
Sr-90	5,359	4.3E-41
Tc-99	2,065	5.5E-08
U-234	3,712	2.5E-07
U-235	3,712	1.3E-08
U-238	3,712	5.9E-08

a. Am-241, Cm-244, Pu-238, and Pu-241 each have relatively low decay half-lives and relatively low mobility. They will decay in place; therefore, it is assumed they instantaneously decay to their first major progeny and are transported as the progeny.

This screening-level conservative groundwater risk assessment demonstrates that the pre-demolition inventory at the hot cells will meet the CERCLA groundwater performance criteria.

4.3 Ecological Risk Evaluation

The screening-level ecological risk evaluation followed the approach presented in the *Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL* (VanHorn, Hampton, and Morris 1995) and documented in the *Comprehensive Remedial Investigation/Feasibility Study for Waste Area Groups 6 and 10 Operable Unit 10-04* (DOE-ID 2001) and the *Risk-Based Screening and Assessment Approach for Waste Area Group 1 Soils* (VanHorn and Stacey 2004).

An ecological risk evaluation was performed to support the Alternative 1 No Action scenario for the TRA-632 Hot Cells. This evaluation used a screening approach to evaluate risk to ecological receptors. The same soil concentrations calculated for the human health risk analysis were used for this analysis. These concentrations were screened to ecologically based screening levels (EBSLs). EBSLs are concentrations in the soil that are not expected to produce any adverse effect to ecological receptors identified as present at the INL Site under chronic exposure conditions. The screening for radionuclides indicated that five EBSLs are exceeded and would present an unacceptable risk to ecological receptors. The five radionuclides that exceeded the EBSLs are Am-241, Ni-63, Pu-238, Pu-239, and Pu-240. Appendix B presents the EBSL screening results.

5. IDENTIFICATION OF REMOVAL OBJECTIVES

The ROD (DOE-ID 1997) and Appendix A of the Explanation of Significant Differences (DOE-ID 2000) established removal action objectives for cleanup of contaminated soils near the ATR Complex. This section identifies the removal action objectives and goals for the activities associated with this removal action.

5.1 Removal Action Objectives

The removal action objectives for this NTCRA are to perform final decommissioning of the TRA-632 Hot Cells consistent with, or more conservative than, the OU 2-13 (DOE-1997) removal action objectives to achieve the following:

- Inhibit direct exposure to radionuclide contaminants of concern that would result in a total excess cancer risk greater than 1 in 10,000 (1E-04) to 1 in 1,000,000 (1E-06) for current and future workers and future residents

- Inhibit ingestion of radionuclide and nonradiological contaminants of concern 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 (1E-04) to 1 in 1,000,000 (1E-06) or a hazard index of 1 or greater for current and future workers and future residents

- Prevent unacceptable internal exposure of 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.

In addition to the remediation objectives established through the FFA/CO (DOE-ID 1991) process, the selected alternative should incorporate the DOE goal of reducing the “risk footprint” to as practicable extent as possible in consideration of ALARA principles governing radiological exposure to decommissioning personnel, safe engineering standards, ICDF WAC, and desired CERCLA site end states.

6. IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES FOR THE TRA-632 HOT CELLS

Three alternatives are proposed for evaluation in the TRA-632 Hot Cells removal action.

6.1 Alternative 1—No Action

Alternative 1, the no action alternative, assumes no removal would be conducted at TRA-632 and there would be no further surveillance and maintenance at this facility.

Under the no action alternative, it is assumed that the building and hot cells degrade over the next 85 years to the point where they crumble to the ground, and contamination becomes available for uptake by a hypothetical future resident and ecological receptors. It is assumed that all the rubble and contamination are lying on top of the ground surface to a depth of 6 in.

6.2 Alternative 2—No Action: Continued Surveillance and Maintenance

Under Alternative 2, there would be no action at TRA-632 except surveillance and maintenance.

Maintenance includes maintaining the TRA-632 building that protects the hot cells from the weather and provides the support systems, such as power and ventilation. Surveillance includes periodic facility inspections to ensure building integrity and systems operability to prevent release of radiological or chemical constituents to the environment causing an unacceptable risk to potential receptors.

6.3 Alternative 3—Removal of the TRA-632 Building and Hot Cells

Alternative 3 fully removes the building down to the slab and removes the three hot cells contained in the building. Wastes from the removal are disposed of at the ICDF. All above-slab portions of the hot cells will either be removed whole or sectioned prior to hoisting onto heavy-haul trailers for transport to the disposal facility. To reduce the spread of radioactive contamination during removal, the internal volume of the cells may be grouted. Under Alternative 3, no hazardous substances would remain above the slab at the hot cell location.

7. ALTERNATIVE ANALYSIS

In accordance with the *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (EPA 1993), the EE/CA's three NTCRA alternatives will be evaluated with respect to three criteria: (1) effectiveness, (2) implementability, and (3) cost.

Effectiveness includes two subcriteria: protectiveness and the ability to meet the removal action objectives. Protectiveness was evaluated based on (1) protectiveness of the alternative for public health and the community, (2) protectiveness of workers during implementation, (3) protectiveness of the environment, and (4) compliance with applicable or relevant and appropriate requirements (ARARs) and other requirements.

Implementability is evaluated based on technical feasibility; availability of equipment, personnel, services, and disposal facilities; and administrative feasibility. Costs are estimated, including capital costs and operations and maintenance costs.

Alternative 2, No Action with Continued Surveillance and Maintenance, is protective of human health and the environment because the facility is maintained so that it does not degrade to the point where contaminants become available to human or ecological receptors. Alternative 2 is only an interim measure that delays a needed future action; therefore, the alternative is not carried forward for the detailed analysis.

7.1 Effectiveness of the Alternatives

The two subcriteria for evaluating effectiveness are protectiveness and the ability to meet the removal action objectives list in Section 5.

7.1.1 Protectiveness

Protectiveness is the primary objective of a removal action and is a threshold criterion that must be met to recommend an alternative. The sections below address protectiveness for a future resident (public health), the onsite worker, and the environment.

7.1.1.1 ***Protectiveness: Public Health.*** As discussed in the human health risk assessment (Section 4.1.4), the total risk from Alternative 1, No Action, would exceed acceptable levels and does not meet the threshold criteria of protecting human health.

Alternative 3 requires removal of the TRA-632 Hot Cells and all materials down to the concrete slab; therefore, there is no unacceptable risk to a future hypothetical resident. Alternative 3 meets the threshold criteria of protecting human health.

7.1.1.2 Protectiveness: Worker Risk. Compared to Alternative 3, Alternative 1 is more protective of the workers because they would be less exposed to industrial hazards and the ionizing effects of radiation. To complete this work under Alternative 3, workers would be in close proximity to hoisting, rigging, and cutting activities and be more at risk to exposure to the effects of radiation.

7.1.1.3 Protectiveness: Environmental Risk. Alternative 1 is less protective of the environment because it leaves the TRA-632 Hot Cells and all of the associated contamination that could become available for uptake by an ecological receptor. The screening-level ecological risk evaluation, discussed in Section 4.1.3, indicated soil concentrations for some radionuclides exceeded

the ecological-based criteria. Alternative 3 is more protective of the environment because it eliminates contaminant loading of the soils.

7.1.1.4 ***Protectiveness: Ability to Achieve Removal Action Objectives.*** Alternative 3 achieves the remedial action objectives consistent with the OU 2-13 ROD (DOE-ID 1997) by removing the contaminant inventory at TRA-632 Hot Cells presenting the unacceptable risk. Alternative 1 does not satisfy the removal action objectives or the DOE goal of reducing the "risk footprint" by consolidating wastes in the ICDF.

7.2 Implementability of the Alternatives

Implementability is evaluated based on technical and administrative feasibility and availability of equipment, personnel, services, and disposal facilities.

7.2.1 Technical and Administrative Feasibility

Alternative 3 is technically feasible. The methods for performing this activity can be planned and engineered using existing available knowledge and procedures that have been performed at the INL Site or elsewhere.

7.2.2 Availability of Equipment, Personnel, and Services

Equipment to support Alternative 3 is either available at the INL Site or is commercially available. The hot cells can be wire-sawed level with the top of the concrete slab, and cranes capable of heavy lifts greater than the combined weight of any grouted hot cell are commercially available. Multi-axle transport vehicles are available to transport weights in excess of 700 tons, which transporting of Hot Cell #3 would require.

Trained personnel are available to perform Alternative 3. Workers will be trained to perform the tasks safely, and mockup situations may be used to gain proficiency. Adequate industrial safety controls are in place to protect workers. Additionally, the work force and management that will perform hot cell removal have been selected for their previous experience and success doing similar work. It is the responsibility of every ICP employee or subcontractor to stop work if the worker feels exposed to an uncontrolled or unacceptable hazard. Every ICP employee or subcontractor has the right to stop work until hazards are mitigated and the work can be performed safely.

The "Occupational Radiation Protection" regulation (10 CFR 835) requires the ICP to develop and implement plans and measures to maintain occupational radiation exposures at ALARA levels (10 CFR 835.101(c) and 10 CFR 835.1001). As applied to occupational radiation exposure, the ICP ALARA process does not require that exposures to radiological hazards be minimized without further consideration, but that such exposures be optimized by taking into account (1) the benefits arising out of the activity, (2) the detriments arising from the resultant radiation exposures, and (3) the controls to be implemented. The primary methods used to maintain exposures at ALARA levels are administrative controls (e.g., radiation work permits, personnel dose tracking, and access controls) and engineering controls (e.g., temporary shielding, containment devices, and filtered ventilation systems), which are used (as appropriate) to control individual exposures to radiation.

Specific hazards associated with implementation of Alternative 3 at the TRA-632 Hot Cells will be identified and mitigated using an integrated safety management process that has been shown to significantly minimize worker potential for injury. Both administrative and engineering controls will be used to protect the workers. Administrative controls include barriers and signage to prohibit nonessential

personnel from hazardous work areas near TRA-632. Accountability of employees and close supervision of employees by competent foreman that match employee's abilities with the tasks to be completed are some of the administrative controls that help workers to work safely. Engineering controls for removal of the hot cells will include hoisting and rigging designed to lift loads safely with significant safety margins designed into lifting lugs, slings, and cranes that bear the load. A trained and experienced health and safety staff will also independently monitor work activities and function as an integral part of the work planning process to ensure controls are implemented in the procedures that the workers are required to follow.

On-Site or off-Site disposal or recycling services are available for wastes generated for Alternative 3.

7.3 Cost of the Alternatives

Detailed cost estimates have been prepared for Alternatives 2 and 3. There would be no costs associated with Alternative 1, No Action, since this is a "true" no action where the TRA-632 Hot Cells are simply left to degrade.

The estimates were prepared in accordance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000). Costs are calculated for both capital expenditures and future surveillance and maintenance expenses. In accordance with EPA guidance, the cost for the alternatives over time is calculated as present net worth costs, which are the costs in 2009 dollars.

Alternative 2 assumes maintenance of the TRA-632 Hot Cells over an 85-year period ending 2095. Alternative 2 would require ongoing surveillance, including routine radiological inspections and instrument checks. Maintenance includes facility repairs, maintaining the ventilation systems and heat, and periodic repair and replacement of TRA-632 roofing. Surveillance and maintenance costs for Alternative 2 would likely go beyond the institutional control period for an indeterminable period of time so the year 2095 was used for comparative purposes.

Alternative 3 includes removing the building interior and structural components as well as the hot cell windows, manipulators, and other equipment and caves exterior to the cells; wire-sawing the hot cells from the floor slab; installing lifting fixtures on the cells and grouting the cells full. Alternative 3 also includes the cost for hoisting, transportation, and disposal of the hot cells at ICDF. Alternative 3 meets the removal action objectives without land use restrictions beyond 2095; therefore, no surveillance and maintenance costs are included.

The information in the cost estimate summary is based upon the best available information regarding the anticipated scope of the removal action alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the performance of the removal action. Major changes will be documented in the form of a memorandum placed into the Administrative Record file. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30% of actual project cost. The cost estimate summary is presented in Table 7-1.

Table 7-1. Cost estimates for the viable removal action alternatives in 2009 dollars.

Feature	Alternative 2 No Action with Continued Surveillance and Maintenance	Alternative 3 Complete Removal of TRA-632 Building and Hot Cells
D&D costs	$0.0 M	$6.3 M
Surveillance and maintenance cost	$22 M (based on an annual average cost of $257K)	$0.0 M
Total estimated cost of the alternative	$22 M	$6.3 M

D&D decommissioning and demolition

7.4 Summary of Alternative Evaluation

The no action alternatives are hypothetical, conservative, baseline assumptions that offer no reduction in toxicity, mobility, or volume of contaminants in that the sum of all identified chemical and/or radiological contamination, if not properly contained or controlled, may be released to the environment, causing an unacceptable risk to potential receptors. These assumptions are for comparative purposes only and do not reflect the DOE mandate to monitor, maintain, and mitigate potential or actual hazardous or radiological constituent releases to the public or the environment from any facility or site. In addition, this alternative does not meet the DOE goal of reducing the "risk footprint" by consolidating wastes in the ICDF and reducing surveillance and maintenance costs on legacy buildings and structures.

Alternative 3 fully removes TRA-632 building and the three hot cells for disposal at the ICDF. Under Alternative 3, no hazardous substances would remain above the slab at the TRA-632 location; therefore, this alternative satisfies the removal action objectives and meets the DOE goals of reducing the "risk footprint" by consolidating wastes in the ICDF and reducing surveillance and maintenance costs on legacy buildings and structures.

8. RECOMMENDED REMOVAL ACTION ALTERNATIVE

The recommended removal action alternative is Alternative 3, complete removal of the TRA-632 building and hot cells and disposal of the wastes at ICDF in accordance with the facility WAC.

ICDF is the only on-Site disposal facility that accepts CERCLA waste generated at the INL Site. It provides many advantages for disposal of this waste:

- The leachate from disposed waste at ICDF is managed using a double geotextile liner for collection.
- ICDF has a lowermost layer of compact clay to protect groundwater by capturing and holding contaminants to prevent migration if the geotextile liners should fail in the future.
- The ICDF WAC was established based on conservative groundwater modeling and compatibility analysis.
- ICDF is located out of the 100-year flood plain.
- Operational controls are in place to minimize void spaces and prohibit free liquids in the waste.
- Wastes are treated as necessary to stabilize them prior to disposal.
- A groundwater monitoring system, which includes perched as well as aquifer wells, provides early detection of releases.
- A waste placement tracking system records the location of the waste in the disposal cell if future retrieval becomes necessary.
- An engineered cover to minimize infiltration of precipitation into the wastes will eventually be added.
- Access controls, monitoring, and maintenance will remain in place for as long as the contents of ICDF remain a threat to human health or the environment if uncontrolled.

The recommended alternative meets the proposed removal action objectives regarding long-term risk and is cost effective. It is also consistent with the remedial action objectives of the OU 2-13 ROD (DOE-ID 1997), is compliant with ARARs, and satisfies the DOE goal of reducing the "risk footprint" to as practicable extent as possible in consideration of ALARA principles governing radiological exposure to decommissioning personnel, safe engineering standards, ICDF WAC, and desired CERCLA site end states.

8.1 Compliance with Environmental Regulations

Section 121 of CERCLA (42 USC § 9621) requires the responsible CERCLA implementing agency to ensure that the substantive standards of HWMA/RCRA and other applicable laws will be incorporated into the federal agency's design and operation of its long-term remedial actions and into its more immediate removal actions. DOE-ID is the implementing agency for this NTCRA. Both the DEQ and the EPA concur that a NTCRA is warranted to protect human health and the environment. Through the NTCRA process, the risks presented in this document will be mitigated in a timely manner.

Table 8-1 lists the proposed ARARs that have been identified for this removal action. These ARARs are a compilation and expansion of the ARARs identified in the OU 2-13 ROD (DOE-ID 1997). The ARARs list is based on several key assumptions:

- The drains and piping are ancillary to the TRA-630 Catch Tank System and have been identified as part of the VCO Action Plan (VCO-5.8.d) and are outside the scope of this EE/CA. Soil contamination, if found under the slab, will be addressed under the future TRA-632 HWMA/RCRA Closure Plan and/or the CERCLA program.

- Lead shielding will be removed from TRA-632 Hot Cells prior to initiation or during this removal action through other regulatory activities intended to place the facility in an environmentally safe condition. Some incidental lead, such as small amounts of lead encapsulated in debris, may be managed under the scope of the NTCRA as CERCLA waste and be disposed of in the ICDF, according to the WAC. Removed lead that cannot be recycled or reclaimed shall be declared a hazardous waste or mixed low-level waste, will be managed in accordance with the substantive requirements of the HWMA/RCRA, and will be disposed of at an off-Site disposal facility in accordance with the disposal facility WAC.

- Management of CERCLA waste generated during the removal action would be subject to meeting the ICDF WAC (DOE-ID 2009).

- If decontamination liquids are generated, they will be disposed of at the ICDF evaporation ponds in accordance with the approved WAC. Small amounts of decontamination liquid may be solidified with absorbent and be disposed of in the disposal cells at ICDF.

- Debris generated during removal of the TRA-632 Hot Cells might have paint that contains PCBs. If encountered, such waste may trigger substantive requirements of the Toxic Substances Control Act (15 USC § 2601 et seq.). Lead-contaminated paint also may be present on demolition debris, which would be subject to the substantive requirements of RCRA hazardous waste regulations. Nonhazardous low-level waste would be disposed of at the ICDF. Waste that can be demonstrated to be nonhazardous and contain no added radiological constituents is eligible for disposal as solid waste at an approved on-Site solid waste disposal facility. Any PCB-containing electrical equipment, such as PCB-containing light ballasts or capacitors, will be removed and disposed of off-Site at an approved disposal facility.

- 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 ICDF and/or, if not radiologically contaminated, at an approved on-Site solid waste disposal. 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."

- 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 are the mercury-containing electrical switches and lights. No mercury at concentrations of regulatory concern is expected to be present in the building substructure at the start of the removal action.

Table 8-1. Summary of applicable or relevant and appropriate requirements for the TRA-632 Hot Cells non-time-critical removal action.

Requirement (Citation)	ARAR Type	Comments
Clean Air Act and Idaho Air Regulations		
"Toxic Substances," IDAPA 58.01.01.161	A	Applies to any toxic substances emitting during implementation of the removal action.
<10 mrem/yr, "Standard," 40 CFR 61.92	A	Applies to the waste handling activities.
"Emission Monitoring and Test Procedures," 40 CFR 61.93	A	Applies to the waste handling activities.
"Compliance and Reporting," 40 CFR 61.94(a)	A	Applies to the waste handling activities.
"Standard for Demolition and Renovation," 40 CFR 61.145	A	Applies to any asbestos-containing materials removed during the decommissioning.
"Rules for Control of Fugitive Dust" and "General Rules," IDAPA 58.01.01.650 and IDAPA 58.01.01.651	A	Applies to the waste handling activities.
Idaho Solid Waste Facilities Act		
"Applicable Requirements for Tier II Facilities," IDAPA 58.01.06.012	A	Applies to disposal of solid wastes.
RCRA and Idaho Hazardous Waste Management Act		
Generator Standards:		
"Standards Applicable to Generators of Hazardous Waste," IDAPA 58.01.05.006, and the following, as cited in it:		
"Hazardous Waste Determination," 40 CFR 262.11	A	Applies to waste that would be generated during the removal action.
General Facility Standards:		
"Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," IDAPA 58.01.05.008, and the following, as cited in it:		
"Temporary Units (TU)," 40 CFR 264.553	A	Waste may be treated or temporarily stored in a temporary unit prior to disposal.
"Staging Piles," 40 CFR 264.554	A	Waste may be temporarily staged prior to disposal.
"General Inspections Requirements," 40 CFR 264.15	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to the ICDF or an off-Site facility.

Table 8-1. (continued).

Requirement (Citation)	ARAR Type	Comments
"Preparedness and Prevention," 40 CFR 264, Subpart C	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to the ICDF or an off-Site facility.
"Contingency Plan and Emergency Procedures," 40 CFR 264, Subpart D	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to the ICDF or an off-Site facility.
"Disposal or Decontamination of Equipment, Structures, and Soils," 40 CFR 264.114	A	Applies to contaminated equipment used to remove, treat, or transport hazardous waste.
"Use and Management of Containers," 40 CFR 264.171-178	A	Applies to containers used during the removal and treatment of hazardous waste.
Land Disposal Restrictions:		
"Land Disposal Restrictions," IDAPA 58.01.05.011, and the following, as cited in it:		
"Applicability of Treatment Standards," 40 CFR 268.40(a)(b)(e)	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.
"Treatment Standards for Hazardous Debris," 40 CFR 268.45	A	Applies to hazardous debris, if treatment is necessary to meet the disposal facility's WAC or if treatment is required before placement.
"Universal Treatment Standards," 40 CFR 268.48(a)	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.
"Standards for Universal Waste Management," IDAPA 58.01.05.016		
"Standards for Large Quantity Handlers of Universal Waste," 40 CFR 273, Subpart C	A	Applies to management of universal wastes.
Idaho Groundwater Quality Rules		
"Ground Water Quality Rule," IDAPA 58.01.11	A	The waste handling activities must prevent migration of contaminants from the TRA-632 Hot Cells that would cause the SRPA groundwater to exceed applicable State of Idaho groundwater quality standards in 2095 and beyond.

Table 8-1. (continued).

Requirement (Citation)	ARAR Type	Comments
TSCA		
"Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," 40 CFR 761	A	Applicable to removal, decontamination, storage, and disposal of items (including equipment) with PCB contamination.
Migratory Bird Treaty Act of 1918		
"Protection of Migratory Game and Insectivorous Birds," 16 USC 7	A	Applies to disturbances of nesting migratory birds.
To-Be-Considered Requirements		
"Radiation Protection of the Public and the Environment," DOE O 5400.5, Chapter II(1)(a,b)	TBC	Applies to the TRA-632 building and hot cells before, during, and after the removal action. Substantive design and construction requirements would be met to keep public exposures as low as reasonably achievable.
"Radioactive Waste Management," DOE O 435.1	TBC	Applies to the TRA-632 building and hot cells before, during, and after the removal action. Substantive design and construction requirements would be met to protect workers.
Region 10 Final Policy on the Use of Institutional Controls at Federal Facilities (EPA 2006)	TBC	Applies to residual waste following completion of the removal action.

A	applicable requirement	ICDF	Idaho CERCLA Disposal Facility	TBC	to be considered
ARAR	applicable or relevant and appropriate requirement	IDAPA	Idaho Administrative Procedures Act	TSCA	Toxic Substances Control Act
CFR	*Code of Federal Regulations*	PCB	polychlorinated biphenyl	USC	United States Code
DOE	U.S. Department of Energy	RCRA	Resource Conservation and Recovery Act	WAC	waste acceptance criteria
EPA	U.S. Environmental Protection Agency	SRPA	Snake River Plain Aquifer		

8.2 Cultural Resources

Section 106 of the "National Historic Preservation Act of 1966" (NHPA) (16 USC § 470 et seq.), as amended, requires agencies to consider the impact of undertakings on properties listed or eligible for listing in the National Register of Historic Places and to consult with the Idaho State Historic Preservation Officer and other interested parties when impacts are likely. It also requires federal agencies to invite the Advisory Council on Historic Preservation to participate in consultation when impacts may be adverse. The NHPA Section 106 process has been tailored to meet the unique needs of the INL Site. Section 110 of the NHPA directs federal agencies to establish programs to find, evaluate, and nominate eligible properties to the National Register of Historic Places, including previously unidentified historic properties that may be discovered during the implementation of a project (36 CFR 800). In addition, the "Archaeological Resources Protection Act of 1979" (16 USC § 470aa–470mm), as amended, provides for the protection and management of archaeological resources on federal lands. Procedures and strategies to tailor these requirements to the unique needs of the INL Site are described in the INL Cultural Resource Management Plan (CRMP) (DOE-ID 2007c). The INL CRMP is implemented through a Programmatic Agreement between DOE-ID, the Idaho State Historic Preservation Officer, and the Advisory Council on Historic Preservation.

The TRA-632 Hot Cells are a historic property, eligible for nomination to the National Register of Historic Places. DOE-ID has made the decision to proceed with demolition of the facility. To mitigate the adverse impacts caused by such action, DOE-ID, through measures outlined in the INL CRMP and by a 2005 Memorandum of Agreement between DOE and the Idaho State Historic Preservation Office (DOE-ID 2005) and the 2004 Programmatic Agreement (DOE-ID 2007c), has committed to the preservation of the TRA-632 building and hot cells history through the completion of large-format photographs of the facility.

DOE was required to review as guidance the most current U.S. Fish and Wildlife Service list for threatened and endangered plant and animal species. DOE-ID determined that none of the alternatives would impact any threatened and endangered species and also determined that formal consultation with the U.S. Fish and Wildlife Service was not required for this action.

8.3 Compliance with Disposal Facility Waste Acceptance Criteria

8.3.1 ICDF Waste Acceptance Criteria

ICDF is an on-Site disposal facility that accepts CERCLA waste generated at the INL Site. TRA-632 Hot Cells waste meets the WAC for disposal at ICDF. Grout will be added to reduce any void spaces to prevent subsidence in the disposal cell.

8.3.2 Achieving Removal Action Objectives

The recommended alternative meets the proposed removal action objectives regarding long-term risk and is cost-effective. Alternative 3 is also consistent with the remedial action objectives of the OU 2-13 ROD (DOE-ID 1997), is compliant with ARARs, and satisfies the DOE goal of reducing the "risk footprint" by consolidating wastes at ICDF and reducing surveillance and maintenance costs on legacy buildings and structures.

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Appendix A

Decayed Soil Concentrations, Minimum Screening Values, and Screening Results

Appendix A

Decayed Soil Concentrations, Minimum Screening Values, and Screening Results

Table A-1. Soil concentrations compared to soil screening levels.

Radionuclide	Minimum SSL	85-year Decayed Soil Concentration (pCi/g)	Decayed Concentration Exceeds SSL?
Ac-225	1.20E+03	5.10E-06	No
Ac-227	3.20E+00	1.73E-04	No
Ac-228	7.30E+02	8.47E-13	No
Am-241	3.70E+00	3.75E+02	Yes
Am-243	1.80E-01	4.03E+00	Yes
At-217	1.70E+12	5.10E-06	No
Be-10	3.50E+01	1.44E-05	No
Bi-210	4.70E+04	2.52E-05	No
Bi-211	3.00E+06	1.72E-04	No
Bi-213	4.70E+04	5.10E-06	No
Bi-214	8.20E+03	4.92E-05	No
C-14	1.30E-01	7.96E+01	Yes
Ce-141	1.10E+02	0	No
Cl-36	1.60E-02	7.33E-06	No
Cm-242	3.50E+02	0	No
Cm-244	7.40E+00	1.27E+00	No
Co-58	2.70E+00	0	No
Co-60	3.60E-02	5.34E+02	Yes
Cr-51	2.40E+02	0	No
Cs-137	6.10E-02	4.11E+03	Yes
Eu-152	4.20E-02	1.52E+03	Yes
Eu-154	5.00E-02	1.61E+02	Yes
Eu-155	3.80E+00	2.20E-01	No
Fe-55	2.90E+03	2.01E-03	No
Fe-59	3.30E+00	0	No
Fr-221	2.30E+06	5.10E-06	No
Fr-223	4.00E+05	2.38E-06	No
Gd-152	1.30E+01	4.14E-09	No
Gd-153	2.20E+01	0	No
H-3	4.20E+00	1.95E-02	No

Table A-1. (continued)

Radionuclide	Minimum SSL	85-year Decayed Soil Concentration (pCi/g)	Decayed Concentration Exceeds SSL?
Hf-175	9.00E+00	0	No
Hf-181	8.90E+00	0	No
I-129	2.20E-01	2.73E-02	No
Ir-192	3.40E+00	0	No
Mn-54	7.00E-01	0	No
Nb-95	6.80E+00	0	No
Ni-59	7.20E+01	2.18E+03	Yes
Ni-63	3.30E+01	4.36E+05	Yes
Np-237	1.40E-01	3.38E+00	Yes
Np-239	6.60E+02	4.03E+00	No
P-32	6.10E+01	3.78E-07	No
Pa-231	6.20E-01	2.62E-04	No
Pa-233	4.20E+01	3.38E+00	No
Pa-234	3.50E+02	1.15E-03	No
Pa-234m	1.50E+07	7.21E-01	No
Pb-209	1.20E+07	5.10E-06	No
Pb-210	1.80E-01	2.52E-05	No
Pb-211	1.50E+05	1.72E-04	No
Pb-214	4.60E+04	4.92E-05	No
Po-210	3.40E+01	2.48E-05	No
Po-211	4.00E+09	4.70E-07	No
Po-213	0.00E+00	4.99E-06	Yes
Po-214	1.20E+15	4.92E-05	No
Po-215	5.50E+13	1.72E-04	No
Po-218	9.40E+09	4.92E-05	No
Pu-238	3.30E+00	6.05E+02	Yes
Pu-239	2.90E+00	1.67E+02	Yes
Pu-240	2.90E+00	1.89E+02	Yes
Pu-241	4.60E+02	7.88E+01	No
Ra-223	6.90E+01	1.72E-04	No
Ra-225	1.20E+02	5.10E-06	No
Ra-226	6.90E-02	4.92E-05	No
Rn-219	8.20E+07	1.72E-04	No
Rn-222	8.30E-07	4.92E-05	Yes
S-35	5.50E+01	0	No
Sb-124	1.60E+00	0	No

Table A-1. (continued)

Radionuclide	Minimum SSL	85-year Decayed Soil Concentration (pCi/g)	Decayed Concentration Exceeds SSL?
Se-75	4.90E+00	0	No
Si-32	8.30E+01	3.78E-07	No
Sr-89	3.80E+01	0	No
Sr-90	6.90E-02	1.34E+01	Yes
Ta-182	1.20E+00	0	No
Tb-160	2.20E+00	0	No
Tc-99	7.00E-02	1.74E+01	Yes
Th-227	1.20E+02	1.70E-04	No
Th-229	5.00E-01	5.11E-06	No
Th-230	3.90E+00	2.70E-03	No
Th-231	3.30E+04	1.44E-01	No
Th-234	2.20E+03	7.21E-01	No
Tl-207	1.70E+07	1.72E-04	No
Tl-209	5.60E+04	1.10E-07	No
U-233	5.00E+00	1.26E-03	No
U-234	5.00E+00	3.58E+00	No
U-235	2.20E-01	1.44E-01	No
U-236	5.30E+00	4.83E-04	No
U-237	3.30E+02	1.93E-03	No
U-238	5.60E+00	7.21E-01	No
W-185	1.80E+03	0	No
Zn-65	1.20E+00	0	No

SSL soil screening level

Appendix B

Ecologically Based Screening Levels Screening Results

Appendix B

Ecologically Based Screening Levels Screening Results

Table B-1. Ecologically based screening levels screening results.

Nuclide	Soil Concentration 2095 (pCi/g)	EBSL (pCi/g)	Calculated concentration > screening values?
Ac-225	5.10E-06	1.70E+01	No
Ac-227	1.73E-04	2.04E+05	No
Ac-228	8.47E-13	3.10E+03	No
Am-241	3.76E+02	1.78E+01	Yes
Am-243	4.03E+00	1.85E+01	No
At-217	5.10E-06	1.38E+01	No
Be-10	1.44E-05	9.63E+03	No
Bi-210	2.52E-05	5.01E+03	No
Bi-211	1.72E-04	No EBSL	No EBSL
Bi-213	5.10E-06	1.15E+03	No
Bi-214	4.92E-05	1.99E+03	No
C-14	7.96E+01	3.94E+04	No
Ce-141	0	1.18E+04	No
Cl-36	7.33E-06	7.84E+03	No
Cm-242	0	1.60E+01	No
Cm-244	1.27E+00	1.68E+01	No
Co-58	0	3.66E+03	No
Co-60	5.34E+02	1.18E+03	No
Cr-51	0	9.39E+04	No
Cs-137	4.11E+03	4.95E+03	No
Eu-152	1.53E+03	2.18E+03	No
Eu-154	1.61E+02	2.48E+03	No
Eu-155	2.20E-01	3.25E+04	No
Fe-55	2.01E-03	2.01E+06	No
Fe-59	0	2.48E+03	No
Fr-221	5.10E-06	1.53E+01	No
Fr-223	2.38E-06	5.47E+03	No
Gd-152	4.14E-09	4.53E+01	No
Gd-153	0	5.32E+04	No
H-3	1.95E-02	3.43E+05	No
Hf-175	0	9.47E+03	No

Table B-1. (continued).

Nuclide	Soil Concentration 2095 (pCi/g)	EBSL (pCi/g)	Calculated concentration > screening values?
Hf-181	0	5.69E+03	No
I-129	2.73E-02	4.76E+04	No
Ir-192	0	3.64E+03	No
Mn-54	0	3.53E+03	No
Nb-95	0	3.56E+03	No
Ni-59	2.18E+03	1.24E+06	No
Ni-63	4.36E+05	1.14E+05	Yes
Np-237	3.38E+00	1.94E+01	No
Np-239	4.03E+00	1.17E+04	No
P-32	3.78E-07	2.79E+03	No
Pa-231	2.62E-04	2.37E+01	No
Pa-233	3.38E+00	1.70E+04	No
Pa-234	1.15E-03	No EBSL	No EBSL
Pa-234m	7.21E-01	2.37E+03	No
Pb-209	5.10E-06	No EBSL	No EBSL
Pb-210	2.52E-05	2.74E+05	No
Pb-211	1.72E-04	No EBSL	No EBSL
Pb-214	4.92E-05	6.78E+03	No
Po-210	2.48E-05	1.84E+01	No
Po-211	4.70E-07	No EBSL	No EBSL
Po-213	4.99E-06	No EBSL	No EBSL
Po-214	4.92E-05	1.27E+01	No
Po-215	1.72E-04	No EBSL	No EBSL
Po-218	4.92E-05	1.62E+01	No
Pu-238	6.05E+02	1.78E+01	Yes
Pu-239	1.67E+02	1.89E+01	Yes
Pu-240	1.89E+02	1.89E+01	Yes
Pu-241	7.88E+01	3.73E+05	No
Ra-223	1.72E-04	No EBSL	No EBSL
Ra-225	5.10E-06	2.00E+04	No
Ra-226	4.92E-05	2.04E+01	No
Rn-219	1.72E-04	No EBSL	No EBSL
Rn-222	4.92E-05	1.78E+01	No
S-35	0	2.59E+04	No
Sb-124	0	1.38E+03	No
Se-75	0	7.63E+03	No

Table B-1. (continued).

Nuclide	Soil Concentration 2095 (pCi/g)	EBSL (pCi/g)	Calculated concentration > screening values?
Si-32	3.78E-07	No EBSL	No EBSL
Sr-89	0	3.34E+03	No
Sr-90	1.34E+01	3.34E+03	No
Ta-182	0	2.31E+03	No
Tb-160	0	No EBSL	No EBSL
Tc-99	1.74E+01	1.60E+04	No
Th-227	1.70E-04	No EBSL	No EBSL
Th-229	5.11E-06	3.60E+01	No
Th-230	2.70E-03	2.09E+01	No
Th-231	1.44E-01	2.33E+04	No
Th-234	7.21E-01	4.16E+04	No
Tl-207	1.72E-04	No EBSL	No EBSL
Tl-209	1.10E-07	No EBSL	No EBSL
U-233	1.26E-03	2.03E+01	No
U-234	3.58E+00	2.05E+01	No
U-235	1.44E-01	2.27E+01	No
U-236	4.83E-04	2.17E+01	No
U-237	1.93E-03	No EBSL	No EBSL
U-238	7.21E-01	2.32E+01	No
W-185	0	1.54E+04	No
Zn-65	0	5.21E+03	No

EBSL ecologically based screening level