



U.S. Department of Energy
Idaho Operations Office

Draft Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials

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November 2013



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ACRONYMS

ACRR	Annular Core Research Reactor	KAFB	Kirtland Air Force Base
APE	area of potential effects		
ATR	Advanced Test Reactor	LCF	latent cancer fatality
		LLW	low-level waste
CFR	Code of Federal Regulations		
		MFC	Materials and Fuels Complex
DOE	U.S. Department of Energy	MLLW	mixed low-level waste
DOE-ID	U.S. Department of Energy – Idaho Operations Office		
DOT	U.S. Department of Transportation	NE	Nuclear Energy (DOE Office)
		NEPA	National Environmental Policy Act
EA	environmental assessment	NHPA	National Historic Preservation Act
ED	effective dose	NRC	U.S. Nuclear Regulatory Commission
EPA	U.S. Environmental Protection Agency	NRHP	National Register of Historic Places
		REM	roentgen equivalent in man
F/CS	filtration/cooling system		
		SNL/NM	Sandia National Laboratories - New Mexico
GHG	greenhouse gas		
GTCC	greater-than-class C	TA	Technical Area
		TREAT	Transient (TR) Reactor (REA) Test (T) Facility
HEPA	High Efficiency Particulate Air		
HFEF	Hot Fuel Examination Facility		
INL	Idaho National Laboratory		
INTEC	Idaho Nuclear Technology and Engineering Center		

HELPFUL INFORMATION FOR THE READER

Scientific Notation

Scientific notation is used to express numbers that are very small or very large. A very small number will be expressed with a negative exponent, such as 1.3×10^{-6} . To convert this number to the more commonly used decimal notation, the decimal point must be moved left by the number of places equal to the exponent, in this case 6. The number thus becomes 0.0000013. For large number, those with a positive exponent, the decimal point is moved to the right by the number of places equal to the exponent. The number 1,300,000 can be written as 1.3×10^6 .

Units

English units are used in this document with conversion to metric units given below. Occasionally, metric units are used if metric is the common usage (i.e., when discussing waste volumes or when commonly used in formulas or equations).

cal/g	calories per gram	J/g	joule per gram	mrem	millirem
cfm	cubic feet per minute	km	kilometers	MT	metric ton
cm	centimeters	kW	kilowatt	rem	roentgen-equivalent-man
ft	foot (feet)	m	meter	pCi/g	picocurie per gram
GSF	gross square ft	mi	mile	T	ton(s)
in.	inch	mi ²	square mi	yr	year

Conversions

English to Metric			Metric to English		
To Convert	Multiply By	To Obtain	To Convert	Multiply By	To Obtain
acres	4.047×10^{-1}	hectares	hectares	2.471	acres
ft/sec	3.048×10^1	cm/sec	cm/sec	3.281×10^{-2}	ft/sec
ft	3.048×10^{-1}	m	m	3.28084	feet
gallons	3.785	liters	liters	2.641×10^{-1}	gallons
mi	1.609334	km	km	6.214×10^{-1}	mi
square mi	2.590	square km	square km	3.861×10^{-1}	square mi
T	9.08×10^{-1}	MT	MT	1.1013	T
yards	9.144×10^{-1}	m	m	1.093613	yards

Understanding Small and Large Numbers

Number	Power	Name
1,000,000,000,000,000	= 10^{15}	quadrillion
1,000,000,000,000	= 10^{12}	trillion
1,000,000,000	= 10^9	billion
1,000,000	= 10^6	million
1,000	= 10^3	thousand
10	= 10^1	ten
0.1	= 10^{-1}	tenth
0.01	= 10^{-2}	hundredth
0.001	= 10^{-3}	thousandth
0.000 001	= 10^{-6}	millionth
0.000 000 001	= 10^{-9}	billionth
0.000 000 000 001	= 10^{-12}	trillionth
0.000 000 000 000 001	= 10^{-15}	quadrillionth

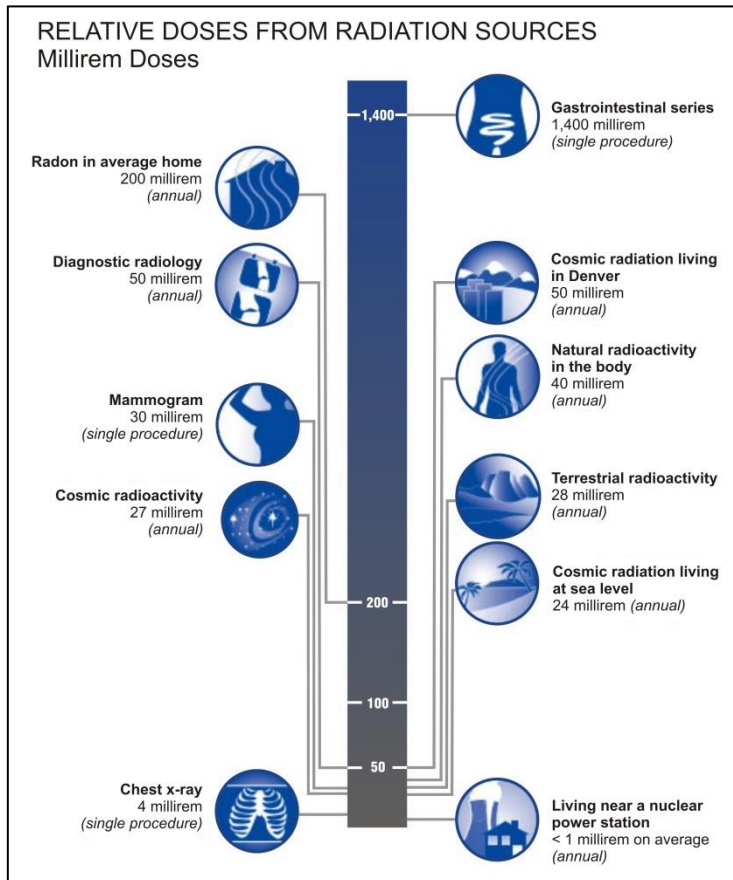
Understanding Dose (Millirem Doses) and Latent Cancer Fatality

Relative Doses¹

A dose is the amount of radiation energy absorbed by the body. The United States unit of measurement for radiation dose is the *rem* (Roentgen Equivalent Man) (see Glossary). In the U.S., doses are most commonly reported in millirem (mrem). A millirem is one thousandth of a rem (1000 mrem = 1 rem). The **inset diagram** compares radiation doses from common radiation sources, both natural and man-made. Use this information to help understand and compare dose information described in this document.

Latent Cancer Fatality calculations

The consequence of a dose to an individual is expressed as the probability that the individual would incur fatal cancer from the exposure. Based on a dose-to-risk conversion factor of 0.0006 latent cancer fatality (LCF) per *person-rem* (see Glossary), an exposed worker receiving a dose of 1 rem would have an estimated lifetime probability of radiation-induced fatal cancer of 0.0006 or 1 chance in 1,700. Equivalently, out of a population of 1,700 exposed persons, one individual would be expected to get cancer.



¹ From <http://www.epa.gov/radiation/understand/perspective.html>

GLOSSARY

Area of potential effects (APE): The geographic area (or areas) within which a federal undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist.

Attainment area: An area considered to have air quality as good as or better than the National Ambient Air Quality Standards as defined in the Clean Air Act. An area may be an attainment area for one pollutant and a nonattainment area for others.

Bounding accident: An accident resulting in the highest dose to facility workers, collocated workers or members of the public.

Cladding: The outer layer of a nuclear fuel rod, which is located between the coolant or test environment and nuclear fuel. Cladding prevents radioactive elements from escaping the fuel into the coolant or test environment and contaminating it.

Clean Air Act: The Federal Clean Air Act is the basis for the national air pollution control effort. Basic elements of the act include National Ambient Air Quality Standards for major air pollutants, hazardous air pollutants, state attainment plans, motor vehicle emission standards, stationary source emission standards and permits, acid rain control measures, stratospheric ozone protection, and enforcement provisions.

Cultural resource: A broad term for buildings, structures, sites, districts, or objects of significance in American history, architecture, archaeology, engineering, or culture which are identifiable through field inventory, historical documentation, or oral evidence. Cultural resources may be, but are not necessarily, eligible for nomination to the National Register of Historic Places (NRHP) (see entry for *historic property*).

Dose consequences: The dose is the consequence of a person being exposed to ionizing radiation. The increased chance of a person getting a cancer as a result of being exposed to the dose is a risk-based consequence. If the dose is high enough, there is a chance the dose will result in a latent cancer fatality. Collectively, dose, chance of getting a cancer, and risk of a latent cancer fatality occurrence is the dose consequence.

Effective dose (ED): The sum of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue.

The effective dose, or ED, includes the committed ED from internal radionuclides deposition and the doses from penetrating radiation sources external to the body. The ED is expressed in units of rem. The U.S. Environmental Protection Agency (EPA) regulations in 40 Code of Federal Regulations (CFR) Part 61, Subpart H specify that estimates of radiological dose to a member of the public be reported in terms of EDE or total ED equivalent, consistent with an older methodology described in International Commission on Radiological Protection (ICRP) Publication 26 (ICRP 1977) and ICRP Publication 30 (ICRP 1979–1988).

Fuel pin/fuel rod: Individual units of clad nuclear fuel.

Historic property: Any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP.

Hodoscope: An instrument used to detect forms of radiation emitted from experiments during a transient experiment. These data are used to monitor the location of nuclear fuel as a function of time during the experiment duration.

Hot cell: Shielded containment chambers that are used to protect workers from radiation by providing a safe containment area in which workers can control and manipulate the equipment required.

Intensive archaeological survey: A field investigation completed to identify cultural resources in areas that have not been previously examined for cultural resources. Spacing between surveyors does not exceed 22 m during pedestrian walkovers.

Latent cancer fatality: The value reported as an LCF is the risk that a death will result from a dose sustained. (see Helpful Information for the Reader).

Light water reactor: A type of nuclear reactor that uses normal water as a coolant and as shielding. A light water reactor is the most common type of reactor used to generate electricity.

National Ambient Air Quality Standards: Standards established by the EPA under authority of the Clean Air Act that apply to outdoor air throughout the country. Primary standards are designed to protect human health with an adequate margin of safety, including sensitive populations (such as children, the elderly, and individuals suffering from respiratory disease). Secondary standards are designed to protect public welfare from any known or anticipated adverse effects of a pollutant.

National Emissions Standards for Hazardous Air Pollutants: The Clean Air Act requires the EPA to regulate airborne emissions of hazardous air pollutants (including radionuclides) from a specific list of industrial sources called "source categories." Each "source category" that emits radionuclides in significant quantities must meet technology requirements to control them and is required to meet specific regulatory limits.

Neutron: A subatomic particle that has no net electrical charge and mass slightly greater than a proton.

Nonattainment area: The Clean Air Act and its amendments in 1990 define a nonattainment area as a locality where air pollution levels persistently exceed National Ambient Air Quality Standards or that contribute to ambient air quality in a nearby area that fails to meet those standards. The EPA gives nonattainment areas a classification based on the severity of the violation and the type of air quality standard they exceed. EPA designations of nonattainment areas are only based on violations of national air quality standards for carbon monoxide, lead, ozone (1-hr), particulate matter (PM-10), and sulfur dioxide.

Nuclear fuel: For the purposes of this document, nuclear fuel is defined as nuclear material—such as uranium, plutonium, or thorium—that is contained and encapsulated in test specimens.

Person-rem: A person-rem is a collective radiation dose applied to populations or groups of individuals. It is the product of the average dose per person (expressed in rem) times the number of people exposed or the population affected.

Prevention of significant deterioration: This term applies to new major sources, or major modifications at existing sources, for air pollutants where the area at which the sources are located is in attainment or unclassifiable with the National Ambient Air Quality Standards. If significant impact levels (as defined in the regulation) are exceeded at any public receptor, a detailed air quality impact analysis is required to determine if controls are necessary to maintain air quality.

Receptors or receptor locations:

Member of the public (public receptor location or hypothetical member of the public): Location where a member of the public could be when the activity is taking place. "Public receptor locations" correspond to the location of either an actual or hypothetical person. These receptor

locations are used because they correspond to those where the highest dose to a member of the public could occur.

Facility worker: Person working inside a facility when the activity is taking place. These workers could be protected by technical safety requirements, administrative procedures, and personal protective equipment that would minimize their dose in event of an accident occurring inside a facility. However, doses provided here do not credit these protective measures.

Collocated worker: Hypothetical person working outside of the facility where the activity is occurring. These workers are less likely to be protected by technical safety requirements, administrative procedures or personal protective equipment when an accident occurs. The doses provided for collocated workers do not credit any protective measures that could be put in place.

Crew member: The driver and co-driver of a transportation vehicle.

Inspector: A collocated worker that is involved in the preparation of the shipment and who accompanies a shipment during transport.

Reconnaissance archaeological survey: A field investigation completed to identify cultural resources in areas that were originally surveyed for cultural resources more than 10 years ago. Pedestrian walkovers are focused in known areas of high archaeological sensitivity, where ground surfaces have changed appreciably (e.g., burned areas), and in the vicinity of previously recorded cultural resources.

REM: The United States unit of measurement, roentgen equivalent in man (REM), is the unit used to express *effective dose (ED)* (see Glossary). It provides a measure of the biologic effects of ionizing radiation. A millirem (mrem) is one thousandth of a rem (0.001 rem), often used to express dosages commonly encountered from medical imaging (x-rays) or natural background sources.

Transient testing: Involves placing the nuclear fuel or material into the core of a specially-designed nuclear reactor and subjecting it to short bursts of intense, high-power radiation. After the experiment is completed, the fuel or material is analyzed to determine the effects of the radiation.

Transient Reactor Test Facility (TREAT): This document will use TREAT to describe the fenced area containing the TREAT Reactor Building and support facilities excluding the TREAT Reactor Control Building.

TREAT Reactor: The nuclear test reactor and reactor support systems inside the TREAT Reactor Building.

TREAT Reactor Building: The building containing the TREAT Reactor and support systems.

TREAT Reactor Control Building: The building housing the TREAT Reactor Control Room. This building is located approximately 0.45 miles southeast of TREAT.

Vadose zone: A subsurface zone of soil or rock containing fluid under pressure that is less than that of the atmosphere. Pore spaces in the vadose zone are partly filled with water and partly filled with air. The vadose zone is limited by the land surface above and by the water table below.

DRAFT ENVIRONMENTAL ASSESSMENT FOR THE RESUMPTION OF TRANSIENT TESTING OF NUCLEAR FUELS AND MATERIALS

1 INTRODUCTION

1.1 Purpose and Need for Agency Action

The U.S. Department of Energy (DOE) has determined a mission need to develop and test advanced *nuclear fuels* (see Glossary) in order to improve nuclear reactor sustainability and performance, to reduce the potential for proliferation of nuclear materials, and to advance the nuclear fuel cycle (DOE 2010). To meet these needs, DOE proposes to re-establish a comprehensive U.S. *transient testing* (see Glossary) program. DOE believes the program will aid in the development of new, advanced, safer, and more efficient fuels that will generate additional quantities of clean, reliable, economical electricity using nuclear power reactors. The transient testing capability will be needed for at least 40 years.

This document describes alternative actions that meet the mission needs and analyzes the potential environmental impacts associated with each alternative.

1.2 Background

The primary mission of the DOE Office of Nuclear Energy (NE) is to advance nuclear power as a resource capable of meeting the nation's energy supply, environmental, and national security needs by resolving technical, cost, safety, and security barriers through research, development, and demonstration as appropriate. NE's research and development activities help address mission challenges, enabling new reactor technologies that will support the current fleet of reactors and facilitate constructing new ones. Mission efforts include developing new and advanced fuels along with enhancing the predictability of fuel behavior under a broad range of abnormal conditions, including loss-of-coolant accident scenarios with fuel damage and melting.

Developing and proving the basis for safe operations of advanced reactors and nuclear fuels requires substantial transient testing. Formulating the safety basis for a reactor system requires a thorough understanding of what could happen to nuclear fuel if it were subjected to accident conditions such as large power increases and loss-of-cooling events. Transient tests are crucial in demonstrating the safety basis of the reactor and the fuel, thus establishing what constitutes safe reactor operating levels.

Advanced reactor designs will require new fuel types. These fuels could be quite different from existing fuels or those tested in the past, with changes including different shapes to enhance their cooling performance, different compositions to help significantly reduce the amount of waste generated during the production of nuclear energy, and different materials to improve their thermal and safety performance. Transient testing plays a significant role in making these determinations.

The U.S. has not conducted significant transient testing on nuclear fuels in over a decade. There are a few limited, small-scale transient testing capabilities currently available (DOE 2010). However these existing U.S. capabilities are insufficient to develop new nuclear fuel designs. Additionally, there are few operating test facilities in the world where testing of newly designed, full-scale nuclear fuel elements can take place, that also possess necessary monitoring and examination capabilities. Therefore, the DOE has determined a mission need for the resumption of domestic transient testing is a critical component in advancing nuclear energy research and development for a new generation of reactors and nuclear fuels, which enables the future deployment of advanced nuclear power.

1.3 Description of Transient Testing

Transient testing involves placing fuel or material, either previously irradiated or un-irradiated, contained in a test assembly (described later in this section) into the core of a nuclear test reactor and subjecting it to short bursts of intense, high-power radiation. During testing, the test assembly is monitored using specialized instruments. After the transient experiment is completed, the fuel or material is examined to determine the effects of the radiation.

In general, there are two types of transient experiments: static tests and closed loop tests. Static tests evaluate the impact of transient conditions on the physical and chemical configuration of nuclear fuel in the presence of static or non-flowing coolant. Closed loop tests evaluate the impact of transient conditions on the physical and chemical configuration of nuclear fuel in the presence of flowing coolant.

Static test assemblies are relatively simple, consisting of nuclear fuel or material sealed inside a capsule with water, helium, or another coolant. The size of a static experiment can be as small as a single test piece (or sample of nuclear fuel) that is contained in a test assembly with nominal outside dimensions of 1 in. in diameter and 6 in. in height. Larger static experiments also may be performed with test assembly dimensions of about 6 in. in diameter and 93 in. in length.

Closed loop test assemblies are more complex and include single rods, rodlets, or a bundle of *fuel pin/fuel rods* (see Glossary) sealed inside a larger test vessel charged with coolant and containing all the pumps and other equipment needed to circulate coolant past the nuclear fuel or materials. Closed loop test assemblies have dimensions of up to 6 in. in diameter and 200 in. in length. Up to 20 static and 14 closed loop tests are anticipated to be conducted annually.

The facilities essential to transient testing include:

- A *hot cell* (see Glossary) for pre-test assembly, pre-test examination, post-test disassembly, and post-test examination.
- A specially-designed transient test reactor that can accommodate the test assembly in the reactor core, operate in steady-state conditions, and provide short-bursts of high-intensity *neutrons* (see Glossary) that mimic accident conditions in a commercial nuclear reactor.

The test reactor must include “in-the-reactor” real-time imaging technology (using a radiation detection system such as a *hodoscope* [see Glossary] or fuel motion monitoring device) and have the ability to induce specific observable changes to nuclear fuel systems.

2 ALTERNATIVES

The Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations require agencies to identify and assess reasonable alternatives (40 Code of Federal Regulations [CFR] 1500.2[e]) when proposing new activities. In line with this requirement, DOE has reviewed and analyzed two reasonable alternatives, plus a third "No Action" alternative, in this environmental assessment (EA).

2.1 Alternative Selection Criteria

DOE developed a set of selection criteria, based on programmatic experimental objectives, to help identify a reasonable set of alternatives to resume full-scale transient testing. Using these criteria, alternatives were identified and evaluated against the selection criteria (DOE 2013).

The selection criteria utilized to identify reasonable alternatives included:

1. Located in the U.S. to provide the necessary access, security, and control to support DOE research activities.
2. Capable of producing transient neutron bursts able to deposit energy of up to 7,000 J/g (1,670 cal/g) into nuclear fuel within periods of less than 1/10th of a second to longer than a minute.
3. Capable of performing transient experiments on test assemblies up to 200 in. in length and 1-6 in. diameter.
4. Capable of performing real-time fuel motion monitoring using a radiation detection system during a transient experiment.
5. Capable of providing the necessary infrastructure to prepare and handle test assemblies (e.g., collocated hot cell facilities).
6. Ability to meet the programmatic timeframe.

2.2 Alternatives Selected for Analysis

Using the criteria identified in Section 2.1, the following alternatives were identified and selected for analysis in this EA (see Figure 1):

- Alternative 1: Restart the Transient Reactor Test Facility (TREAT) Reactor at the Idaho National Laboratory (INL).
- Alternative 2: Modify the Annular Core Research Reactor (ACRR) at Sandia National Laboratories in New Mexico (SNL/NM).
- Alternative 3: No action.

Several additional alternatives were considered but not evaluated because they did not meet the selection criteria. These included construction of a new transient test reactor or the use of the High Flux Isotope Reactor at Oak Ridge National Laboratory, the Advanced Test Reactor (ATR) at INL, the Nuclear Safety Research Reactor in Japan, CABRI in France, the Impulse Graphite Reactor in Kazakhstan, and the Missouri University Research Reactor.

DOE has selected Alternative 1 as the preferred alternative. The "preferred alternative" is the alternative that DOE believes would fulfill its statutory mission and responsibilities in the best manner, giving consideration to economic, environmental, technical and other factors. It is identified to inform the public of DOE's orientation in regards to achieving the proposed action. The main factors that support DOE's choice of a preferred alternative include the remoteness of the INL and the *TREAT* (see Glossary), the resultant smaller potential radiation doses to workers and the public, the operational flexibility provided by Alternative 1 with respect to necessary

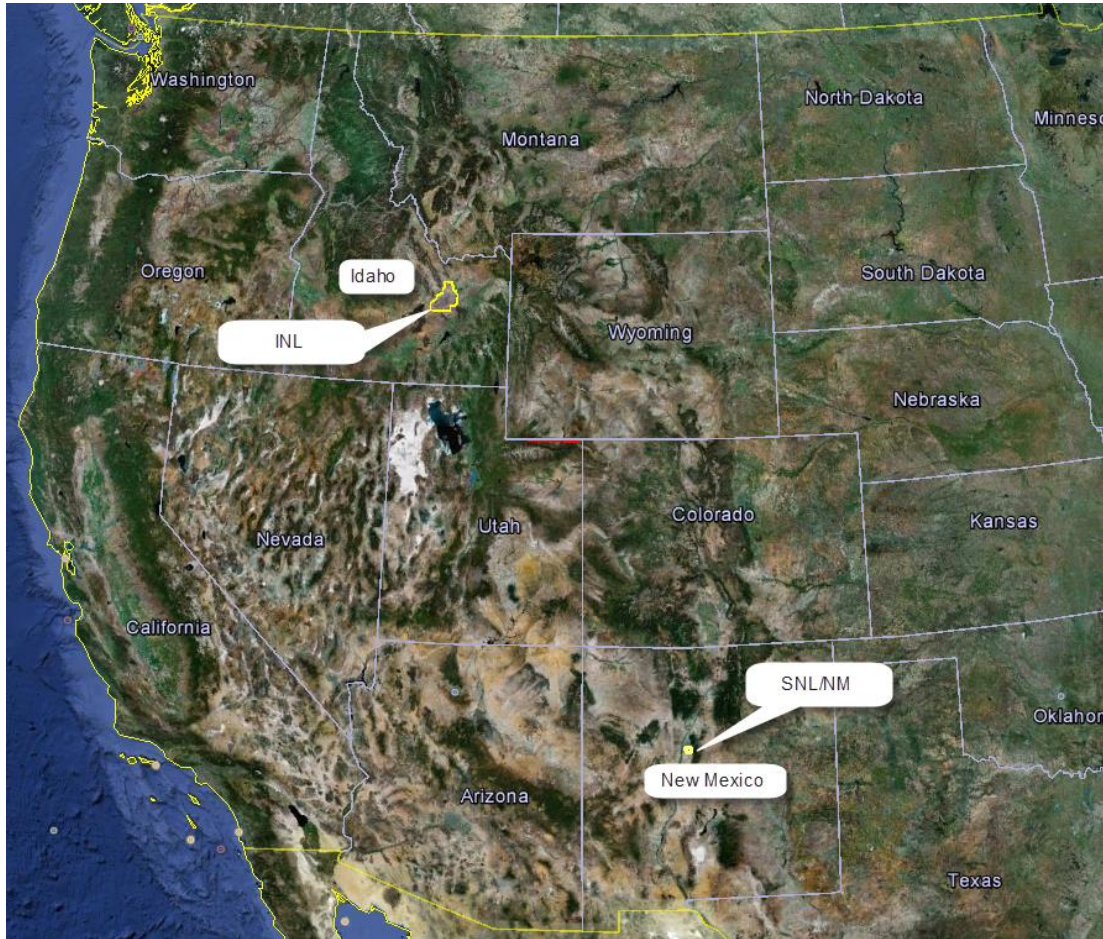


Figure 1. Location of the two alternatives: TREAT is located on the INL Site in Idaho (Alternative 1 DOE’s Preferred Alternative, Section 2.2.1,) and the ACRR is located on SNL/NM located southeast of Albuquerque, New Mexico (Alternative 2, Section 2.2.2). (Base map courtesy of Google Earth).

facilities, the conduct of experiments, and the lower potential for impacts from transportation of experiments.

2.2.1 Alternative 1 – Restart the TREAT Reactor (Preferred Alternative)

Activities involved would include refurbishment or like-for-like replacement of systems and equipment that prepare the TREAT Reactor for restart and operations. Refurbishment will affect the TREAT Reactor Building, TREAT Reactor Control Building, and the cable corridor between them. Supporting activities such as pre- and post-test examinations, experiment assembly and disassembly, and waste management would be conducted at onsite INL facilities. The INL facilities, other than TREAT, would remain within their current operating requirements and limitations. Transient irradiations would be conducted in the TREAT Reactor. Transportation of fuel and test assemblies would occur on the INL site using roadways controlled by INL security.

TREAT is located in the south-central portion of the INL Site in southeast Idaho (see Figures 1 and 2). Although TREAT is part of the Material and Fuels Complex (MFC), the fences that surround the MFC main facilities and TREAT are separated by about 0.6 miles (see Figure 2). Original construction of TREAT was completed in November 1958. The reactor began operating on February 23, 1959. TREAT was a principal reactor safety testing facility in the U.S. for 35 years,

performing transient tests on thermal and fast reactor fuels. Since 1994, the TREAT Reactor has been maintained in a standby status (reactor placed in a safe configuration).

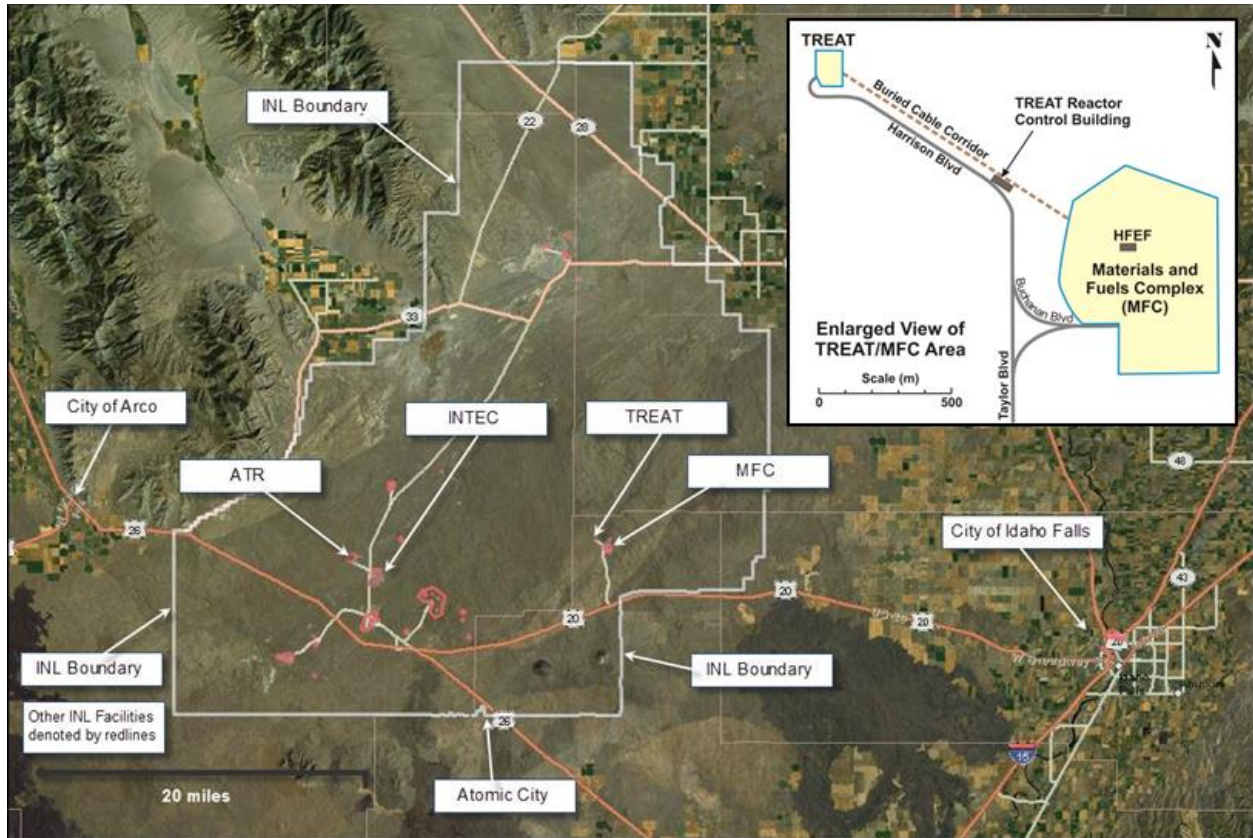


Figure 2. Location of TREAT (near center of figure) and the Materials and Fuels Complex (MFC) within the INL boundary, shown in relation to nearby facilities and cities.

Primary buildings that would support transient testing at TREAT include the TREAT Reactor Building and the TREAT Reactor Control Building. The TREAT Reactor Building contains the TREAT Reactor, and a high bay for receipt and handling of test assemblies and for decontamination after irradiation. The TREAT Reactor Control Building contains computer consoles (located about 0.45 miles southeast of the Reactor Building).

TREAT was specifically designed to test nuclear fuel and materials under transient (or high-power) conditions. The TREAT Reactor is cooled by air at or near atmospheric pressure. The TREAT Reactor core was designed to accommodate a variety of test assemblies that contain a variety of coolants such as sodium or water. Because the core is air cooled, a test assembly can be easily inserted into the core, then observed and monitored during testing. Horizontal, line-of-sight access to the core is possible by removing shielding blocks along the sides of the reactor. Line-of-sight access to the core is required to allow real-time fuel motion monitoring of the nuclear fuel or materials during a transient test. Vertical access to the core is possible by removing shielding blocks above the reactor. Real-time fuel motion monitoring during a transient test at TREAT is accomplished with a hodoscope (see Figure 3).

TREAT includes several buildings within a fenced property, including the TREAT Reactor Building (MFC -720), a guardhouse (MFC-722), warehouse (MFC-723) and ancillary buildings outside the fence. The TREAT Reactor Control Building (MFC-724) and the original TREAT Reactor Control Building (MFC-721) are located about 0.45 miles east (see Figure 2).

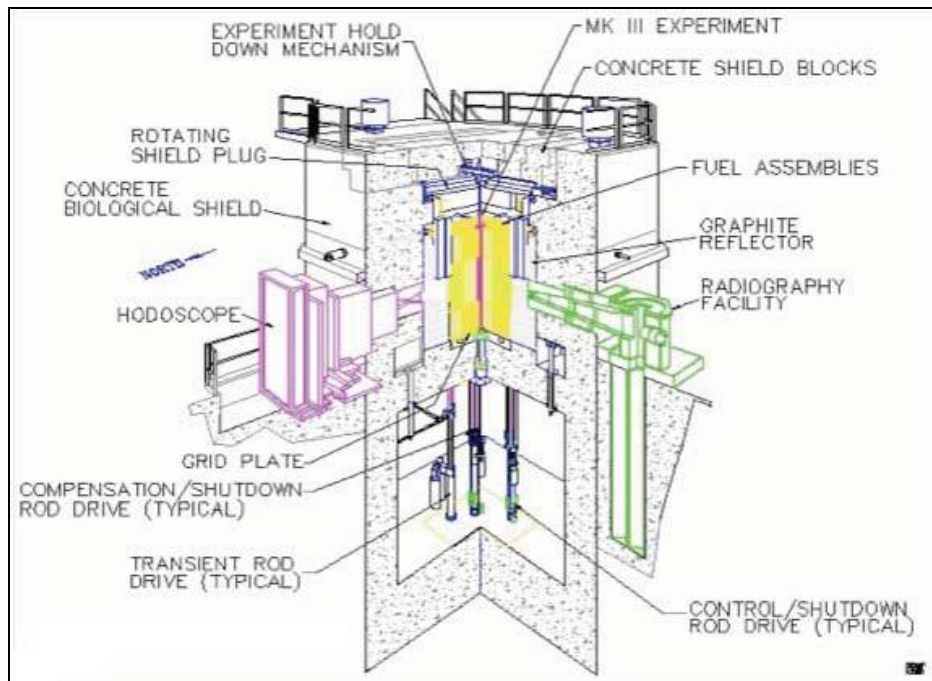


Figure 3. Diagram of the TREAT Reactor with a test assembly (MK III experiment) inserted into the center of the reactor core and showing the hodoscope (or fuel motion monitoring device) left of the reactor core.

TREAT is currently used for inspection and surveillance of nuclear material stored in the facility (including reactor fuel in storage); radioactive and nuclear material receipt, storage, and handling (e.g., radioactive sources); non-reactor training and experiments involving radioactive and nuclear material along with radiation generating devices; and maintenance of the facility structure and equipment therein. Current activities that are inconsistent with transient testing operations would not continue at TREAT if the TREAT Reactor is restarted.

Resumption of transient testing at TREAT would involve detailed evaluation of TREAT Reactor systems against applicable codes and standards, refurbishment/replacement as necessary to ensure compliance, maintenance of compliant system components, and demonstration of readiness to ensure safe operation of the reactor. Activities associated with restarting the TREAT Reactor would be conducted in accordance with Federal, state and local regulations (see Section 5) and in accordance with established best management practices to minimize the impacts of restart activities.

Normal operations of the reactor would include routine maintenance of equipment in TREAT and associated support buildings and structures and specific transient testing activities. Transient testing using the TREAT Reactor would involve the following activities:

1. Transportation of the fuel or material to MFC for pre-experiment examination and test assembly preparation; activities would occur primarily at the Hot Fuel Examination Facility (HFEF) at MFC.
2. Transportation of the test assembly to TREAT from MFC.
3. Transient irradiation(s) of the test assembly at TREAT, including pre- and post-irradiation radiography.
4. Transportation of the test assembly back to MFC.
5. Post-irradiation examination of the test assembly components at HFEF or other MFC facilities.

2.2.2 Alternative 2 – Modify the ACRR

Activities under Alternative 2 would require modification of facilities at SNL/NM, the use of existing facilities at INL, and transport of experiments between INL and SNL/NM. Activities involved would include modifying ACRR to include a real-time fuel motion monitoring device and building a hot cell adjacent to the reactor building. Preliminary experiment assembly and disassembly, pre- and post-examination, and waste management activities would be conducted at INL. Transient irradiations would be conducted in the ACRR. Fuel and experiments would be transported between facilities at INL and between INL and SNL/NM.

The ACRR is located within the boundary of Kirtland Air Force Base (KAFB)—southeast of the city of Albuquerque, New Mexico—and within SNL/NM’s Technical Area (TA)-V (see Figures 1 and 4). The ACRR is a water-cooled, pulse-type research reactor and has been in continuous operation since 1979, logging more than 10,000 operations. ACRR can be run in steady-state mode as well as a programmed combination of steady-state and pulsed transients. Although the ACRR is water-moderated, there is a large, dry, central cavity that extends through the center of the core (see Figure 5).

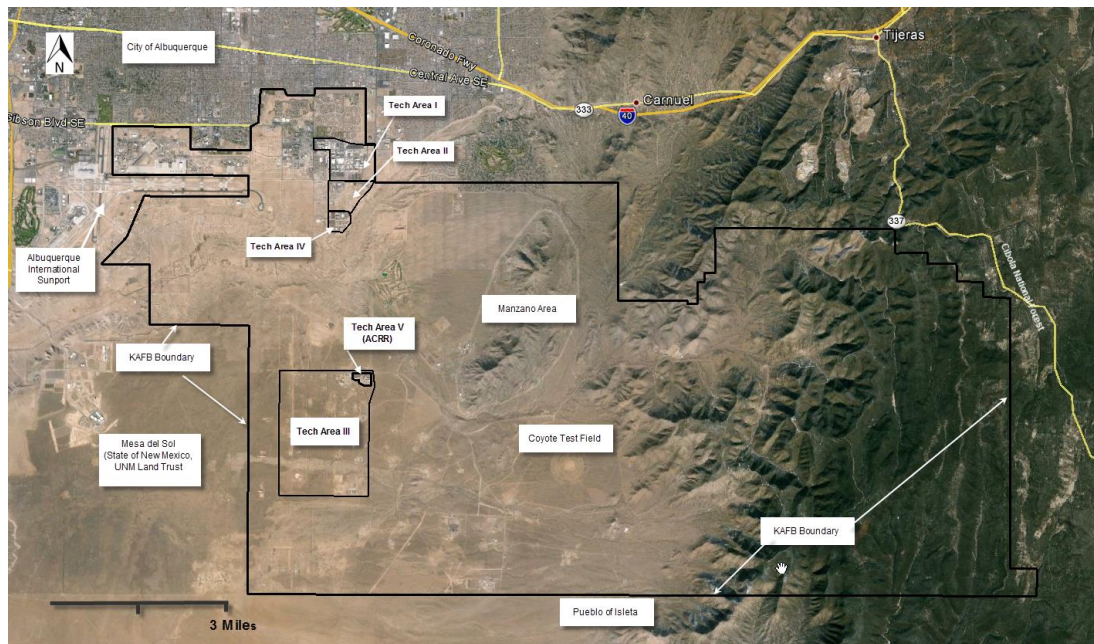


Figure 4. Location of key points of interest in and adjacent to Technical Area-V at SNL/NM. Information from DOE 1999. (Base map courtesy of Google Earth).

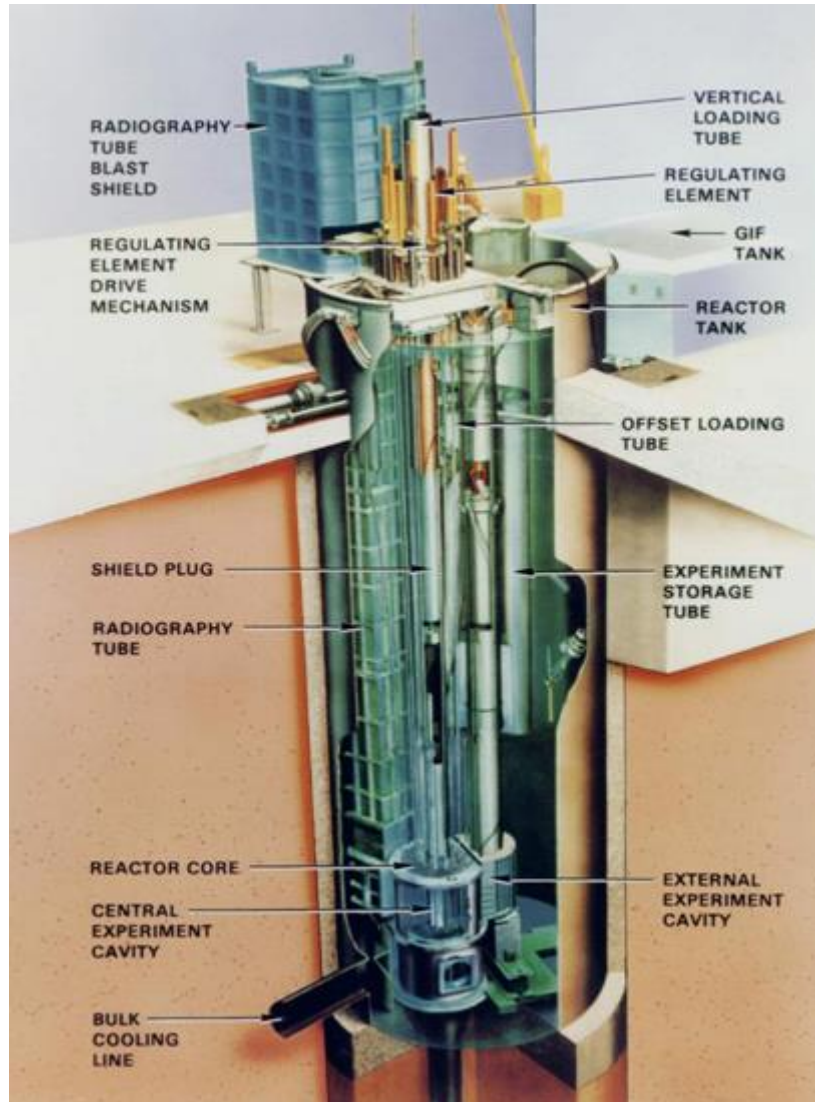


Figure 5. Diagram of ACRR.

ACRR is a unique facility that has been historically used for a wide array of research. Although the current mission is focused on supporting the DOE National Nuclear Security Administration's nuclear security and weapons mission, past missions have served the U.S. Nuclear Regulatory Commission (NRC) and DOE-NE for fuels, safety, and isotope production missions. When the ACRR was transitioned from the Annular Core Pulsed Reactor with a new fuel form, the purpose was to enable larger pulses and the ability for the driving core to bring the test specimen fuel to complete failure without failure of the core's fuel. In addition, a fuel motion monitoring device—the Coded Aperture Imaging System—was successfully installed and used in the reactor to monitor these fuel safety studies that included flowing steam over an array of *light water reactor* (see Glossary) fuel (Kelly and Stalker, 1981). The fuel motion monitoring device has since been removed due to lack of need. As part of this Alternative, a new fuel motion monitoring device would be installed in the reactor.

Use of ACRR for the transient testing mission described in this document would include modifying ACRR to include a real-time fuel motion monitoring device and building a hot cell adjacent to the reactor building. Following construction, readiness to operate would be demonstrated through a series of readiness assessments. All activities would be conducted in

accordance with Federal, state and local regulations (see Section 5) and in accordance with established best management practices to minimize construction impacts.

Transient testing activities using the ACRR would be very similar to the activities associated with conducting transient testing at TREAT and would include:

1. Transportation of the fuel or material to MFC for pre-experiment examination and test assembly preparation; activities would occur primarily at HFEF within MFC.
2. Transportation of the test assembly components to TA-V at SNL/NM.
3. Assemble test components in the new ACRR hot cell.
4. Transient irradiation(s) of the test assembly at ACRR, including pre- and post-irradiation radiography.
5. Transportation of the test assembly back to MFC at INL.
6. Post-irradiation examination of the test assembly components at HFEF or other MFC facilities.

2.2.3 Alternative 3 – No Action

DOE considered a “No Action” alternative that establishes a baseline against which this EA compares the other analyzed alternatives. No action does not necessarily mean doing nothing, but often involves maintaining or continuing the existing status or condition.

In this document, no action means: (1) Not restarting the TREAT Reactor and (2) Not modifying the ACRR to conduct transient testing as described in previous sections. Under this alternative, limited aspects of transient testing would still be pursued at a combination of U.S. and international research facilities capable of conducting the work. For example, in the U.S., transient testing would be limited to conducting static tests of un-irradiated fuel. Single fuel pins could be tested using international capabilities. However, the capabilities that do not exist currently in the U.S. would not be developed. Capabilities that would not be available include:

- The ability to perform transient tests on pre-irradiated large test specimens or full-scale fuel rods
- The ability to perform transient loop-testing of multiple un-irradiated and pre-irradiated fuels
- The ability to perform real-time in-situ imaging during transient testing.

Not having these capabilities would limit testing capabilities needed to provide additional information on fuel and material behavior, negatively impacting the development and improvement of advanced nuclear fuels and fuels used in light water reactors, high temperature gas reactors, and fast reactors; efforts to improve nuclear reactor sustainability and performance; and efforts to minimize the proliferation potential of nuclear materials. The No Action alternative does not meet the mission need.

3 AFFECTED ENVIRONMENT

3.1 Idaho National Laboratory, Idaho

3.1.1 General Description of INL Site and Surrounding Area

The INL Site consists of several facilities, each taking up less than 2 square miles, located across an 890 square miles expanse of otherwise undeveloped, cool desert terrain. DOE controls all of the INL Site land, which is located in southeastern Idaho and includes portions of five Idaho counties: Butte, Bingham, Bonneville, Clark, and Jefferson. Population centers in the region include the cities (>10,000 people) of Idaho Falls, Pocatello, Rexburg, and Blackfoot, located further than 30 miles to the east and south; there are also several smaller cities/communities (<10,000 people), including Arco, Howe, Mud Lake, Fort Hall Indian Reservation, and Atomic City, located around the site less than 30 miles away. Craters of the Moon National Monument is less than 20 miles to the west of the western INL boundary; Yellowstone and Grand Teton National Parks and the city of Jackson, Wyoming are all located more than 70 miles northeast of the closest INL boundaries.

Populations potentially affected by INL Site activities include INL Site employees, ranchers who graze livestock in areas on or near the INL Site, hunters on or near the INL Site, residential populations in neighboring communities, travelers along U.S. Highway 20/26, and visitors at the Experimental Breeder Reactor I National Historic Landmark. There are no permanent residents on the INL Site.

The five Idaho counties that are part of the INL Site are all in an *attainment area* (see Glossary) or are unclassified for *National Ambient Air Quality Standards* (see Glossary) status under the *Clean Air Act* (see Glossary). The nearest *nonattainment area* (see Glossary) is located about 50 miles south of INL in Power and Bannock counties. INL is classified under the *Prevention of Significant Deterioration* (see Glossary) regulations as a Class II area—an area with reasonable or moderately good air quality.

Surface waters on the INL Site include the Big Lost River and Birch Creek. Both streams carry water on an irregular basis, with the majority of the flow diverted for irrigation before entering INL. Most of INL is underlain by the Snake River Plain Aquifer, which lies between 220 ft (at the north end of the Site) to 610 ft (at the south end of the Site) below the surface of the Site. The geology above the Snake River Plain Aquifer—the *vadose zone* (see Glossary)—is generally comprised of basalt (95%), with a layer of soil or sediment on top of the basalt, and thin layers of sediments (1 to 20 ft intervals) between basalt flows. The Snake River Plain Aquifer has similar geology as the overlying vadose zone and is generally 250 to 900 ft thick.

The natural vegetation of the INL Site consists of a shrub overstory with a grass and forb understory. The most common shrub is Wyoming big sagebrush, though basin big sagebrush may dominate or co-dominate in areas with deep or sandy soils. The shrub understory consists of native grasses (Shumar and Anderson 1986).

A wide range of vertebrate species are located within the Site. Several species are considered sagebrush-obligate species, meaning that they rely upon sagebrush for survival. These species include sage sparrow, Brewer's sparrow, northern sagebrush lizard, Greater sage-grouse, and pygmy rabbit (Rowland, et al. 2006).

There are currently no species that occur on the INL Site that are listed as endangered or threatened. However, several Species of Concern or Candidate Species do occur on the Site including sage-grouse, three species of bats (long-eared myotis, small-footed myotis, Townsend's big-eared), pygmy rabbit, Merriam's shrew, long-billed curlew, ferruginous hawk, northern sagebrush lizard, and loggerhead shrike. In 2010, the little brown myotis was petitioned for emergency listing under the Endangered Species Act. The U.S. Fish and Wildlife Service is

collecting information on this species, as well as the big brown bat, to determine whether or not such listing is warranted.

The INL Site has a rich and varied *cultural resource* (see Glossary) inventory. Resources include:

- Prehistoric archaeological sites representing aboriginal hunter-gatherer use over a span of at least 13,500 years
- Late 19th and early 20th Century historic archaeological sites representing emigration, settlement and agricultural development, ranching, freighting, and other activities
- Historic architectural properties that tell the history of the INL Site from its beginnings as a Navy gunnery range to its many important achievements in nuclear science and technology
- Areas and natural resources of cultural importance to the Shoshone-Bannock Tribes and other local or regional stakeholders (e.g., historical societies, historic trail organizations).

Many of the cultural resources identified at the INL Site are *historic properties* (see Glossary) eligible or potentially eligible for listing on the National Register of Historic Places (NRHP). Aviators Cave is one site on the INL that is listed on the NRHP for significant archaeological deposits and cultural value to the Shoshone-Bannock Tribes. In addition, Experimental Breeder Reactor I is recognized as a National Historic Landmark for significant scientific contributions.

3.1.2 TREAT and MFC Area (Area Potentially Affected by Alternative 1)

TREAT is located a little more than 0.6 miles to the northwest of MFC, outside the main fence. A paved access road to TREAT leads from MFC past the TREAT Reactor Control Building to the TREAT Reactor Building. The TREAT Reactor Control Building is about 0.45 miles from TREAT. A fence surrounds the perimeter of TREAT and encloses about 3.5 acres (see Figure 2). The area between the TREAT reactor control buildings (MFC-721 and MFC-724) and TREAT has been previously disturbed. A wildland fire burned through the area as recently as 2010. The remaining vegetation is crested wheatgrass (a non-native species that is well adapted to thrive in localized conditions), a few localized sagebrush adjacent to the cable corridor (a soil mound structure, about 0.5 miles in length covering cables between the reactor control building and TREAT), and native species on the south and west sides of TREAT.

Archival and record searches in 2013 of the INL Built Environment (refers to buildings, structures, objects, and systems built from 1942 to present) revealed historic buildings within the direct *area of potential effects (APE)* (see Glossary) for the proposed action that are eligible for listing on the NRHP. They include the TREAT Reactor Building (MFC-720), and the original TREAT Reactor Control Building (MFC-721) located to the northwest of MFC, HFEF (MFC-785) at MFC, and ATR (TRA-670). The TREAT Reactor Control Building, original TREAT Reactor Control Building, and ATR were constructed during INL's historic period of significance (1942-1970). In 1980, the TREAT Reactor Building was modified and the original control building was remodeled into offices to support the mission of Experimental Breeder Reactor II, which transitioned to the Integral Fast Reactor (IFR) in the mid-1980s. Other facilities that could be used by the program were constructed after 1970, are not exceptionally significant, and are not eligible for listing on the NRHP (Pace and Williams, 2013).

Prehistoric archaeological artifacts from approximately 13,000 to 150 years old, including short-term hunting campsites, lithic scatters (relating to stone tools), and isolated artifact locations, have been identified during surveys of the area surrounding MFC. Archaeological resources dating to historic times (50-150 years old) are also present in the area and include trash scatters, field scars, rock features, and isolated artifact locations (Pace and Williams, 2013).

Several species of wildlife use the area surrounding TREAT and the reactor control buildings. Sage-grouse have been documented using an area 2.3 miles to the southwest of TREAT, and the

closest active lek (breeding area) is located 2.5 miles to the southwest of TREAT. Elk, pronghorn, and mule deer have been documented using water sources in this area. In addition, big brown bats, western small-footed myotis, and Townsend's big-eared bats have used the MFC wastewater ponds and the concrete bridge at MFC (Whiting and Bybee 2011).

There are no perennial or permanent surface water bodies near MFC. All facilities within the MFC fenced area are in a single local-topographically-closed watershed. The MFC watershed contains natural drainage channels, which can concentrate overland flow during periods of high precipitation or heavy spring runoff. TREAT is located in an adjacent local-topographically-closed watershed, which also contains no identifiable perennial, natural surface water features. The elevation of TREAT is 5,122 ft, more than 7 ft above the water level predicted to occur under the probable maximum flood event corresponding to repeated rainfall events over frozen ground; therefore, TREAT is not subject to flooding.

3.2 Sandia National Laboratories, New Mexico

3.2.1 General Description of SNL/NM and Surrounding Area

Sandia National Laboratories – New Mexico (SNL/NM) operations are conducted on about 8,800 acres of federal land on KAFB. KAFB is about 7 miles southeast of downtown Albuquerque (see Figure 4) (SNL/NM 2012). SNL/NM is located within Bernalillo County and adjacent to the Albuquerque city limits.

The local topography of the Albuquerque area is dominated by the Sandia Mountains and Rio Grande River. The Sandia Mountains rise steeply, immediately north and east of the city, with the Manzanita Mountains extending to the southeast. The Rio Grande River runs southward through Albuquerque and is the primary river traversing central New Mexico.

New Mexico has an estimated population of 2 million residents. The largest city is Albuquerque with about 552,804 metro-area residents; other neighboring metro areas include the City of Rio Rancho with 89,320 residents and Bernalillo with 8,480 residents. The population within a 50 miles radius of SNL/NM is over 685,000 residents; nine counties are contained or partially included in that radius (SNL/NM 2012). The nine counties include: Cibola, McKinley, Sandoval, Bernalillo, Santa Fe, San Miguel, Torrance, Socorro, and Valencia.

Although the area within the boundaries of KAFB is federally-owned, ownership and administrative responsibilities of the area and adjacent land are complex. KAFB shares facilities and infrastructure with several associates, including the DOE. It is comprised of approximately 51,560 acres of land, including portions of Cibola National Forest withdrawn in cooperation with the United States Forest Service. It is geographically bounded by the Pueblo of Isleta to the south, the Albuquerque International Sunport (airport) and lands held in trust by the state of New Mexico to the west, and the city of Albuquerque to the north. The eastern boundary lies within the Manzanita Mountains (Figure 4). The western portion of KAFB contains both DOE land and U.S. Air Force land, with areas permitted for DOE/Sandia use.

SNL/NM is comprised of TAs I through V on DOE land, numerous facilities on Department of Defense owned/DOE leased land, and several facilities off KAFB on non-government-owned lands (see Figure 4) (SNL/NM 2012).

SNL/NM is in the Albuquerque Middle Rio Grande Intrastate Air Quality Control Region, referred to as Region 152 (SNL/NM 2012). The U.S. Environmental Protection Agency (EPA) has classified Air Quality Control Region 152 as follows in Title 40, CFR, Section 81.332 (SNL/NM 2012), for these primary air pollutants:

- Sulfur Dioxides (SO₂): Better than national standards
- Ozone (O₃) : Unclassifiable/attainment

- Total Suspended Particulate Matter: Not meeting the primary standards or better than national standards
- Nitrogen Dioxide (NO₂): Cannot be classified or better than national standards
- Carbon Monoxide (CO): Unclassifiable/attainment
- Lead (Pb): Not designated.

The regional hydrogeologic conditions within the Albuquerque Basin are defined by the surface water and groundwater features and the geologic units present. The dominant surface water feature is the Rio Grande River, which flows through the basin generally north to south. The groundwater-bearing units of the basin are the unconsolidated deposits of the Santa Fe Group (a group of similar geologic materials), which comprise the main aquifer. Thickness of the vadose zone material (material between the ground surface and the water table) varies from about 500 ft in the western portion of the KAFB and SNL/NM area to a negligible amount in the eastern portion (SNL/NM 1998).

The general road network leading to KAFB includes Interstates 25 and 40. Interstate 25 runs north-south and is approximately 1.5 miles west of the KAFB boundary at its nearest point. Interstate 40 runs east-west through Albuquerque and is approximately 1 mile north of the KAFB boundary at its nearest point.

Access to KAFB and SNL/NM consists of an urban road network maintained by the city of Albuquerque, the gates and roadways of KAFB, and SNL/NM-maintained roads. Traffic enters SNL/NM through three principal gates: Wyoming, Gibson, and Eubank. Most commercial traffic enters through the Eubank gate because it provides direct access to the SNL/NM shipping and receiving facilities located in TA-II. An additional entrance to KAFB, the Truman gate, serves KAFB's western areas.

SNL/NM maintains approximately 20 miles of paved roads, 25 miles of unpaved roads, approximately 80 acres of paved service areas, and approximately 80 acres of paved parking (DOE 1999). The roads near SNL/NM experience heavy traffic in the early morning and late afternoon. The principal contributors are SNL/NM staff and other civilian and military personnel commuting to and from KAFB. SNL/NM and DOE commuters represent approximately 36% of commuter traffic on KAFB (DOE 1999).

Primary air service is provided for the entire region by the Albuquerque International Sunport, located immediately northwest of KAFB. Runways and other flight facilities are shared with KAFB.

Two major physiographic provinces influence the flora and fauna of the region: (1) Mesa and plains and (2) Mountains (SNL/NM 2012). The topography of the KAFB and SNL/NM area ranges from lowland grasslands to high-elevation coniferous forests. With much of the area undeveloped, there is great diversity in plant and animal communities within the KAFB and SNL/NM area. At least 267 plant species, 206 bird species, 34 reptile/amphibian species, 25 small mammal species, 2 ungulate species (KAFB 2007), 13 bat species (KAFB 2009), and 13 predator species (KAFB 2006) have been documented on KAFB. There are 25 species that are either federal or state listed as: T&E, candidate, or species of concern, occurring in Bernalillo County (SNL/NM 2012). In 2012 the U.S. Fish and Wildlife announced a petition to list the desert massasauga (a snake) as Endangered or Threatened and to designate critical habitat, which occurs in TA III and could occur in TA V.

3.2.2 Technical Area V (TA-V) (Area Potentially Affected by Alternative 2)

TA-V is an area of about 33 acres located in the north-central portion of KAFB (see Figure 4) and adjacent to the northeast section of TA-III. TA-V is a relatively small research area consisting of about 35 closely grouped structures where experimental and engineering research reactors are located. These facilities are used to routinely handle radioactive materials used in experimental

research and development programs and include the Gamma Irradiation Facility, the ACRR, the Hot Cell Facility, and the Auxiliary Hot Cell Facility. Approximately 150 personnel work in the area. TA-V has some planned landscaping, but it predominantly consists of paved, rock, or gravel roads and parking areas and has been deemed as an urban/landscaped area.

A biological Standard Conservation Area has been proposed for the area within TA-V and adjacent TA-III. The Standard Conservation Area was established due to the heavy use of this habitat and to a higher amount of incidental use by the following bird species: eastern meadowlark, western meadowlark, loggerhead shrike, sage sparrow, and Cassin's sparrow. There are no federally-listed threatened or endangered plants or animal species present in TA-V or the surrounding area (KAFB, 2006, 2007, and 2009).

Cultural resources include archaeological, traditional, and built environmental resources, including district sites, buildings, structures, or objects from both the prehistoric and historic eras of human history. TA-V has been surveyed for archeological sites (both prehistoric and historic) (DOE 1999). Aside from isolated occurrences of artifacts, no prehistoric or historic archeological sites have been identified (DOE 2006). Currently, nine buildings (including the ACRR) or structures in TA-V (referred to as the "Reactor Complex Historic District") are recommended as eligible for the NRHP (SNL/NM 2011).

The ACRR is one of several facilities at SNL/NM that is required by *National Emissions Standards for Hazardous Air Pollutants* (see Glossary) to annually report radionuclide source emissions that have the potential to produce a specific dose.

Flooding events have been evaluated to support ongoing ACRR operations. TA-V is not within the 500 year floodplain and is elevated relative to surrounding topography; therefore, significant flooding is not considered credible. Floodplains occur next to the major arroyos and are approximately 0.5 miles from TA-V.

4 ENVIRONMENTAL CONSEQUENCES

DOE uses engineered and administrative controls to ensure safety and to minimize the potential for environmental consequences for its operations. Both the TREAT Reactor and the ACRR were designed to minimize the impacts of reactor operations under normal and accident conditions. Design features will be augmented by operational requirements and administrative controls for reactor operations to ensure operating parameters are not exceeded during steady-state or transient testing conditions.

Test assemblies will be designed to contain the nuclear fuel or materials during planned tests and under all credible accident conditions. Fresh clad fuels (unirradiated) will be in sealed containment. Irradiated fissile materials or fission products will be sealed and will have single or double containment, as appropriate, with the containment designed to retain its integrity. Pre-experiment evaluation and analysis will be conducted to ensure the experiments are within established operating parameters.

4.1 Alternative 1 – Restart the TREAT Reactor (Preferred Alternative)

The TREAT Reactor is currently maintained in a standby condition, and as such, refurbishment activities, facility commissioning, and reactor operations must be considered for purposes of determining whether there are significant environmental impacts that could result from implementing this alternative.

4.1.1 Restart and Normal Operations Activities

Activities associated with the restart of the TREAT Reactor have the potential to affect the TREAT Reactor Building, TREAT Reactor Control Building, and the cable corridor. Activities that are part of normal transient testing operations at TREAT are discussed in Section 2.2.1.

Normal transient testing operations involve activities that would be conducted at MFC, irradiation of the test assembly in the reactor, steady-state and transient operation of the reactor, transportation of the test assembly, and disposition of generated waste. The detailed analyses of the impacts of these activities are contained in Schafer et al. (2013).

Understanding Normal TREAT Reactor Operations

During the sequence of events that would take place under normal operating conditions, the TREAT Reactor is operated under steady-state and transient conditions, and heat is generated in the reactor and test assembly. The TREAT Reactor is a small test reactor, and the heat generated is low enough to be removed using an air filtration/cooling system (F/CS) as opposed to using liquid coolant, required by most commercial reactors. Two blowers operating in parallel, located downstream of the reactor, pull coolant air from the reactor high bay into the reactor core. After passing through the core, the cooling air passes through two banks of High Efficiency Particulate Air (HEPA) filters before being discharged out the reactor coolant exhaust stack.

The air F/CS for the TREAT Reactor is designed to be highly reliable. The F/CS is designed to entrain radioactive aerosols (particulates) in the clean coolant air by first providing subatmospheric pressure in the reactor cavity. The cool air stream passes through the HEPA filters where more than 99% of particulates are entrained on the HEPA filters prior to the remaining gas-phase effluent being discharged up the stack.

To ensure the reliability of the F/CS system, the blowers have historically been powered from independent power sources. One power source is the normal Site electric power; the other is an onsite diesel generator. An additional generator is used to supply standby power to other electrical systems.

Releases to the Air

Non-Radiological Emissions—

The annual cumulative diesel fuel usage for the diesel generators is estimated to be 2,500 gallons based on historical average use and planned future testing demands. The 6-year average diesel fuel usage for all emergency diesel generators and boilers at MFC is 449,563 gallons, and the total INL diesel fuel usage is 1,114,995 gallons. Over the last few years, DOE has implemented sustainability initiatives at MFC and planned improvements at ATR to reduce these emissions. The average fuel usage is expected to continue to decline. The diesel generator fuel consumption at TREAT would represent a small percentage of INL diesel use and resultant emissions (Schafer et al. 2013).

There should be no visible trace of the cooling air at the top of the TREAT Stack. The HEPA filters will remove more than 99% of particulates entrained in the air stream. The reactor cooling air would not carry other volatile chemical pollutants.

Radiological Impacts of Atmospheric Releases—

Radioactive emissions released from the TREAT Stack are the result of activation of naturally occurring Ar-40 (an isotope of Argon) that is present in the cooling air and fission of uranium impurities in the Zircaloy *cladding* (see Glossary) of the TREAT Reactor fuel (see Table 1). Atmospherically transported radioactive emissions were evaluated at the following three locations (see Figure 6) (Schafer et al. 2013).

1. **Atomic City:** Permanent residents at this location will receive the highest public receptor effective dose (ED) (see Glossary). The estimated ED is 2.1×10^{-3} (0.0021) mrem/year.
2. **Treat Reactor Control Building (MFC-721):** The location of the nearest collocated worker would receive an ED of 3.6×10^{-3} (0.0036) mrem/year.
3. **Frenchman's Cabin:** This location is located just south of the southern INL boundary, 23 miles west-southwest of TREAT and is used to show INL-wide compliance with 40 CFR 61, Subpart H. Members of the public are often at this site, but there are no permanent residents or INL workers. To show compliance, the dose at this location is summed with all other atmospheric radionuclide emissions originating at INL. The total dose reported for INL compliance in year 2012 was 3.57×10^{-2} (0.0357) mrem/year (U.S. Department of Energy-Idaho Operations Office [DOE-ID] 2013a). Inclusion of the ED contribution from the TREAT Reactor (estimated to be 1.1×10^{-3} (0.0011) mrem/year) would result in a total annual dose at Frenchman's Cabin of 3.68×10^{-2} (0.0368) mrem.

The EDs from normal operations at these locations are well below the 10 mrem/year federal standard set by 40 CFR 61, Subpart H – National Emissions Standards for Hazardous Air Pollutants. Cumulative doses from all INL sources would also be well below the 10 mrem/year dose standard.

Table 1. Radionuclide emissions at the top of the TREAT Stack for two air flow rates.

Parent Isotope	Parent Half-Life	Progeny ^a	Progeny Half-Life	Parent Phase	Annual Activity (Ci)	
					6,000 cfm	3,000 cfm
Ar-41	1.82 hr	-	-	Gas	350	350
Kr-85m	4.48 hr	Kr-85	10.73 yr	Gas	1.40	1.40
Kr-87	1.27 hr	Rb-87	4.8×10^{10} yr	Gas	8.00	8.00
Kr-88	2.84 hr	Rb-88	17.7 min	Gas	5.60	5.60
Rb-88 ^b	17.7 min	-	-	Solid	0.03	0.05
Xe-133	5.24 d	-	-	Gas	0.70	0.70
Xe-135	9.1 hr	Cs-135	2.3×10^6 yr	Gas	1.40	1.40
Xe-140 ^b	13.6 sec	Cs-140	1.06 min	Gas	2,375	1,163
Cs-140 ^b	1.06 min	Ba-140	12.75 d	Solid	1,028	1,120
Ba-140	12.75 d	La-140	1.68 d	Solid	0.01	0.02
La-140	1.68 d	-	-	Solid	6×10^{-7}	2×10^{-6}

- a. Progeny: The decay product, daughter product, or daughter isotope produced as a (parent) radionuclide undergoes radioactive decay
- b. Release not directly measured, but presence and activity inferred from other data.

Note: For this table – sec = seconds, min = minutes, hr = hours, d = days, and yr = year.

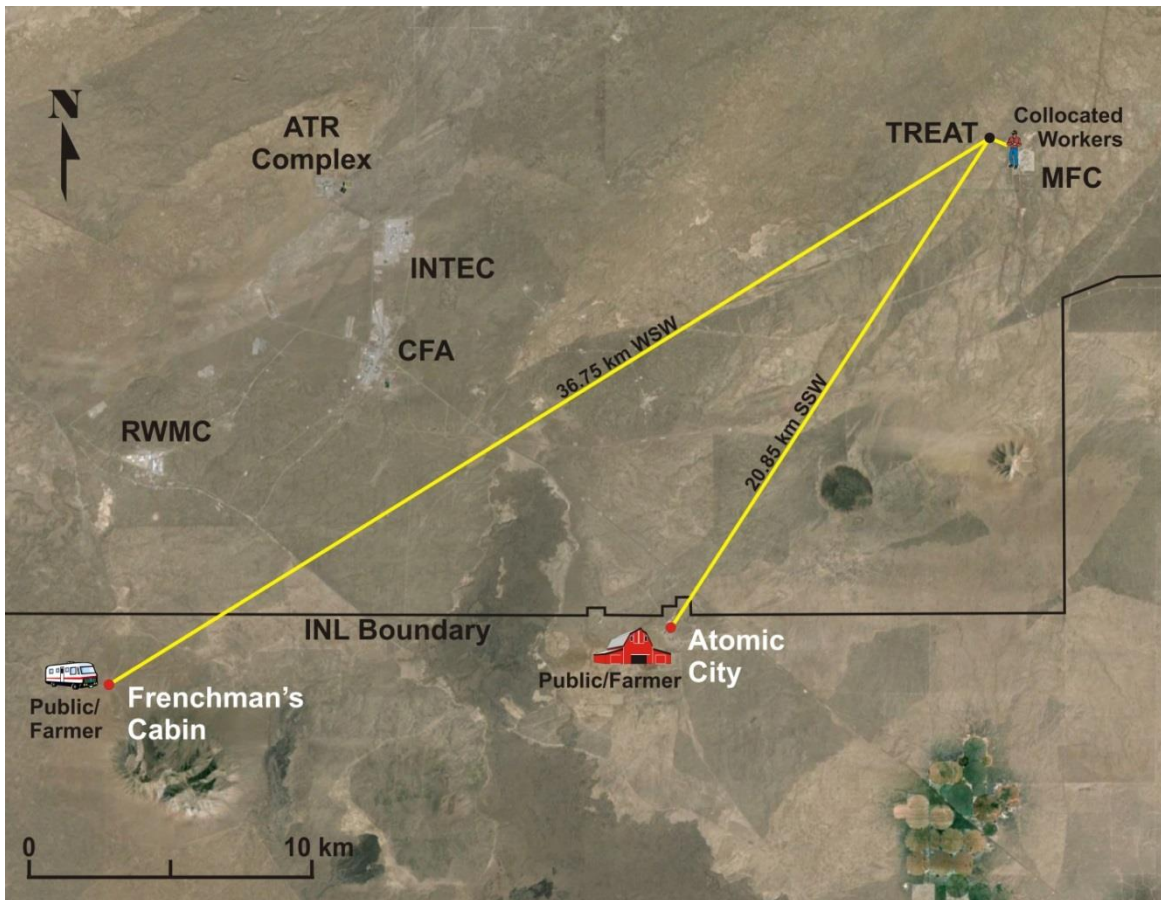


Figure 6. Receptor locations for the air pathway analysis showing distance and direction from TREAT to Frenchman's Cabin, Atomic City, and Collocated Workers (Base map courtesy of Google Earth).

Radiological Impacts of Releases to Soil—

The potential for TREAT Stack emissions to result in contamination beyond the vicinity of TREAT is unlikely based on the atmospheric pathway analysis (Schafer et al. 2013).

Radiological Impacts to Groundwater—

Radionuclide transport from potentially contaminated soils to groundwater is improbable given the short half-lives of the TREAT Stack emissions and the time necessary for a conservative tracer to travel from land surface to the aquifer (about 1,000 years) (Schafer et al. 2013). During the time necessary for the longest lived particulate radionuclide, Ba-140, to travel to the aquifer, negligible radiological activity would remain. The radioactive dose impact to humans would therefore also be negligible (Schafer et. al. 2013).

Impacts to Biological Resources

Potential impacts to biologic resources include those resulting from pre-operations disturbance of soils and plants during restart activities and deposition of radiologic particulates during operations. Impacts associated with refurbishment and replacement of TREAT Reactor systems would be limited to areas within TREAT, parking areas, and the cable corridor that parallels the roadway from the TREAT Reactor Control Building to TREAT (see Figure 2).

Plants and Soil Disturbance Impacts—

Plant populations surrounding TREAT are expected to be minimally impacted by this alternative, with the exception of activities occurring within in the cable corridor (see Figure 2), a previously disturbed area. Minimizing the area of disturbance and managing weeds would help control noxious weeds and invasive species. Reseeding and revegetating with native species would stabilize soil and, coupled with an active weed management program, would limit growth of noxious weeds and invasive species. There would be no direct impact to species of published ethnobotanical concern (plants used by indigenous cultures) or to sensitive species, as there are none present near TREAT or along the cable corridor.

Wildlife Impacts—

A variety of small and large mammals and birds (e.g., badgers, elk, pronghorn, bats, and sage-grouse) use the area around TREAT, including the areas near the cable corridor and TREAT Reactor Control Building. Activities that disturb vegetation and soil would have small-scale, short-term-unavoidable impacts to wildlife species, including loss of certain ground-dwelling wildlife species and associated habitat. Impacts to sage-grouse are not anticipated because of the limited amount of disturbance planned, the lack of suitable habitat in the potentially impacted area, and the long distance from TREAT to the nearest active lek (breeding area).

These short-term impacts would be minimized by limiting the disturbance footprint, implementing a weed management strategy, and promptly stabilizing the disturbed areas. Any activity planned to occur between May 1st and September 1st that potentially disturbs vegetation or soils would require a nesting bird survey before disturbance.

Radiological Impacts to Plants and Animals—

Based on the analysis of particulate emissions from the TREAT Stack, only Ba-140 poses a potential threat to plants and animals. The dose limit for Ba-140 is 7.32 pCi/g for terrestrial animals and 3.84×10^4 pCi/g for terrestrial plants. The predicted soil concentration resulting from normal operations at TREAT is 1.47 pCi/g, which is well below the dose limits for both animals and plants. Therefore, the potential impact to biota is low (Hafla et al. 2013).

Ecological Research and Monitoring—

DOE's Ecological Service Contractor conducts yearly breeding bird surveys along a route near MFC, TREAT, and the TREAT Reactor Control Building. This survey is conducted in June (Shurtliff, et al. 2009). There would be no effect from Alternative 1 on the continuity and utility of the breeding bird survey route.

Impacts to Cultural Resources

The direct APE where impacts to cultural resources could occur is limited to the buildings, their parking lots, and the gravel aprons that surround them; the roadway between TREAT and the TREAT Reactor Control Building; the buried cable corridor that parallels the road; and the narrow strip of land between the buried cable corridor and the adjacent road where staging, laydown, and temporary parking areas may occur.

Field surveys in 2013 demonstrated that no archaeological resources are located in the direct APE (Pace and Williams 2013), and, based on these results, Alternative 1 poses no direct threat to archaeological resources. Adverse impacts to resources that are important to the Shoshone-Bannock Tribes are also unlikely given the absence of archaeological resources and the small area of ground disturbance associated with Alternative 1.

Although direct impacts are unlikely, there is some potential for undesirable indirect effects to archaeological resources that are located within about 330 ft of the defined direct APE for Alternative 1 (i.e., Indirect APE). For example, human activity is likely to increase during soil disturbing activities and operations, and any archaeological resources or natural resources of potential concern located within the indirect APE may be subject to unauthorized collection or impact by off-road vehicle use and other small ground disturbing activities that commonly occur around active developed areas.

Resident and migratory birds and animals of tribal concern may also be temporarily disturbed, and noxious and invasive weeds may increase due to the detriment of native species (as described earlier). Visual impacts associated with soil disturbing activities (fugitive dust) and plant operations are expected to be minimal due to their temporary occurrence and consistency within the range of activities that have historically occurred within this established industrial landscape.

DOE would monitor and protect the single archaeological site identified in the indirect APE, and no impacts are anticipated at this location. Rehabilitation of soil disturbance would minimize adverse impacts to plants and wildlife of concern to the Shoshone-Bannock Tribes.

The TREAT Reactor Building (MFC-720) and original Reactor Control Building (MFC-721) are potentially eligible for listing on the NRHP. The proposed adaptation, re-use, and continued use of these historic properties are consistent with original missions related to nuclear reactor testing and are considered beneficial.

Activities associated with TREAT Reactor restart are consistent with routine activities that have been previously screened and determined to not pose a threat to cultural resources (DOE-ID 2013b). The proposed activities at other INL facilities are operational only, would not involve construction or modifications, and do not have the potential to impact these historic properties. Cultural resource investigations within the direct APE support a finding of no adverse effects to historic properties under the National Historic Preservation Act (NHPA) and no adverse impacts to any known resources of cultural significance based on activities associated with TREAT Reactor restart (Pace and Williams 2013).

Impacts of Waste Generation and Management

Waste would be generated during activities required to restart the TREAT Reactor, routine transient testing operations at TREAT and TREAT Reactor Control Building, and specific to the experiments at MFC.

Preparing to Restart the TREAT Reactor—

Various refurbishment and like-for-like replacement activities would be required for this alternative. These activities would generate non-radioactive electronic waste, scrap metal, and other construction-related debris. Construction debris, electronic waste, and scrap metal would be recycled to the extent possible. Other restart activities could require disposal of construction debris, concrete, coolants, and hydraulic/lubricating fluids. These wastes could be recycled or disposed at on-site facilities or sent off-site. The various non-radioactive waste volumes generated as part of the TREAT Reactor restart is expected to be less than 800 m³, some of which can be recycled. The INL industrial waste landfill disposes of about 23,000 m³ of waste and trash each year.

The two diesel generators—30 kW standby generator and the 130 kW redundant power generator—would be refurbished to meet current Clean Air regulations or replaced.

Low-level radioactive waste (LLW) generated during restart preparations may include contaminated scrap metal, HEPA filters, used personal protective equipment, wipes, rags, and decontamination fluids. Solid LLW would be sent to an off-site disposal facility permitted/licensed to accept LLW. Liquid LLW would be solidified and sent to an off-site disposal facility permitted/licensed to accept LLW. The volumes of these various LLWs generated during refurbishment and replacement activities are expected to be less than 100 m³. During the past three years, INL sent an average of 1,300 m³ LLW to off-site facilities for disposal each year.

No mixed low-level waste (MLLW) (waste which is both radioactive and hazardous) is anticipated to be generated during restart preparations. If MLLW were generated, it would be accumulated and stored in accordance with federal and state regulations, treated if required, and disposed at an off-site permitted facility.

Routine Maintenance and Operations at the Reactor Building and Reactor Control Building—

The waste generated at TREAT would be minimal since the test assemblies would be brought into the facility intact, irradiated, and removed from the facility as intact assemblies. Routine maintenance and operations at TREAT would generate a variety of waste streams, including both radioactive and non-radioactive wastes. Non-radioactive wastes would include trash and waste found at any industrial facility, including common trash, wastewater, hydraulic and lubricating fluids, scrap metal, and possibly small amounts of hazardous waste. Common trash would be disposed at the on-site industrial waste landfill. Hydraulic and lubricating fluids would be recycled or disposed at an off-site permitted facility. Non-radioactive scrap metal would be recycled. Hazardous waste generated at TREAT, if any, would be accumulated and stored in accordance with federal and state regulations, treated and disposed at an off-site permitted facility.

Wastewater at TREAT would be generated from sinks and floor drains. Water would be collected in a 1,000-gallon tank where it would be sampled for radioactive and chemical constituents before disposal. If no radioactive constituents are detected, then the water could be discharged to either the MFC industrial waste pond or the sanitary waste pond in accordance with DOE Orders and state regulations. Historical records indicate TREAT generated less than 1,600 gallons of wastewater a year; the current wastewater discharge rate to the industrial and sanitary waste ponds from on-going MFC activities is about 10 million gallons a year. To reduce waste volumes the water is removed by heating and evaporation and remaining solids residue are disposed of as LLW. So TREAT wastewater residue would add 1 m³ per year.

Solid LLW may include scrap metal, HEPA filters, used personal protective equipment, wipes, rags, and decontamination fluids. Solid LLW would be sent to an off-INL disposal facility permitted/licensed to accept LLW. Liquid LLW would be solidified and sent to an off-site disposal facility permitted/licensed to accept LLW. The volume of various LLW generated during routine operations are expected to be less than 2 m³ per year. The additional LLW disposal due to these

operations would represent less than a 1% increase in the volume sent to off-site disposal facilities each year.

No MLLW is anticipated to be generated during routine maintenance and operations. If MLLW were generated, it would be accumulated and stored in accordance with Federal and state regulations, treated if required, and disposed at an off-site permitted facility.

Experiment Handling and Examinations in HFEF and Other MFC Facilities—

Resuming transient testing at TREAT would result in waste generation at the facilities where the test assemblies are assembled, disassembled, and analyzed. The materials and fuel specimens proposed for TREAT experiments would not be appreciably different from past TREAT Reactor tests. Therefore, the waste streams were assumed to be similar as well (Adams, et al. 2013).

DOE estimates that up to 12 m³ of LLW would be generated each year as a result of assembling, transporting, irradiating, disassembling, and analyzing test assemblies at MFC. Based on INL's average annual LLW generation rate of 1,300 m³, the increase in LLW generation would represent less than 1% of the volume generated at the INL each year. Transient testing activities would generate an estimated 6 m³ of transuranic waste, greater-than-class C (GTCC) waste, GTCC-like waste, or Spent Nuclear Fuel debris over the 40 year life of the program.

INL currently has operating waste management facilities and required permits to manage all wastes that are anticipated to be generated as a result of resuming transient testing. LLW and transuranic radioactive waste would be sent to existing disposal facilities. If generated, GTCC and GTCC-like wastes would be sent to one of the facilities DOE is currently evaluating in the Environmental Impact Statement for the Disposal of GTCC LLW and GTCC-Like Waste (DOE/EIS-375). Spent nuclear fuel debris would be securely stored with DOE's spent fuel and spent fuel debris inventory awaiting a future disposal facility. The increase in waste generation would have negligible environmental impacts.

4.1.2 Accident Consequences

Accident consequences for Alternative 1 were evaluated for events related to the operation of the TREAT Reactor, including refueling, experiment handling at TREAT and MFC (excluding transportation which is covered in Section 4.1.3), and transient testing at TREAT (Schafer et al. 2013).

Overview of Accident Analysis

The accident analysis was conducted by:

1. Identifying radiologic inventories that would be contained in the test assembly and the TREAT Reactor core that present the highest dose potential (i.e., bounding inventory).
2. Identifying potential accident scenarios that could involve operation of the TREAT Reactor, handling the TREAT Reactor fuel and test assembly, and those that could occur during the process of transient testing using the TREAT Reactor.
3. Calculating the annual frequency of occurrence for each accident scenario and calculating the probability of each accident scenario occurring during the 40-year Resumption of Transient Testing program lifetime.
4. Identifying receptor locations for dose calculations. Receptor locations included those for *facility workers* (see Glossary), *collocated workers* (see Glossary) and members of the public.
5. Calculating the doses for each receptor and numbers of estimated cancer fatalities that could result from the dose *latent cancer fatality (LCF)* (see Glossary).

Radiologic Consequences

Results of the accident analysis conducted for operations at TREAT are summarized in Table 2. The analysis of accident scenarios looked at events that could be caused by a range of natural phenomena hazards (seismic, wind, flood etc.), operator errors, and equipment failure. The highest consequence events can be summarized as follows:

- Experiment handling event impacting the TREAT Reactor:** Higher accident-related worker doses would likely result from equipment failure or operator error as opposed to routine irradiation using the TREAT Reactor. Transient testing requires moving the experiment assembly above the reactor. A handling accident involving the experiment above the TREAT Reactor has a one in 25,000 chance of occurring in any given year. The probability of this type of accident occurring once during the 40 year program lifetime is one in 625.

It is improbable that dropping an experiment assembly into the reactor would result in a fire or inability to safely shutdown the reactor, but the drop could damage the fuel in the experiment and could damage the TREAT Reactor fuel cladding. If the drop resulted in a release of gas or particulates from the fuel, facility workers in the building could receive a radiologic dose from the release. In addition, it is assumed that a release occurring in the building would be transported downwind from the building eventually reaching the INL boundary, where members of the public could be affected.

- TREAT Reactor fuel clad failure:** The highest dose or risk of LCF (*dose consequence* [see Glossary]) for members of the public could occur if the TREAT Reactor fuel cladding is compromised. During transient testing, facility workers and collocated workers would be located in the TREAT Reactor Control Building. So, even though public doses are higher than in the previous scenario, facility worker doses are lower. The TREAT Reactor fuel clad could be compromised if the reactor safety features failed during a transient test. There is a one-in-270,000 chance that the redundant reactor safety features would fail in any given year. The probability of the safety features failing once during the 40 year transient testing program is one in 6,750. Therefore, this accident is extremely unlikely to occur.

Table 2. Summary of dose impacts for the highest consequence events for Alternative 1.

Receptor	Dose	LCF ^a
Experiment handling event impacting the TREAT Reactor		
Facility Worker ^b	6 rem/min	NA ^c
TREAT Collocated Worker ^d	2 rem	1 chance in 830
Offsite <i>Member of the Public</i> (see Glossary)	0.08 rem	1 chance in 21,000
Treat Reactor fuel clad failure		
Facility Worker	7 rem	NA ^c
TREAT Collocated Worker	7 rem	1 chance in 240
Offsite Member of the Public	0.2 rem	1 chance in 8,300
a. See definition in 'Glossary' or understanding LCF under 'Helpful Information For the Reader'. b. Facility worker doses do not credit protective actions or equipment. Administrative controls and protective actions and equipment would be used to mitigate worker doses. c. Administrative controls and protective actions and equipment would be used to mitigate facility worker doses. Therefore, no LCF are anticipated. d. Collocated worker doses for this event were evaluated at 300 m to remain consistent with the analysis for Alternative 2.		

Doses and LCFs for members of the public are negligible for all scenarios. Administrative controls and protective actions and equipment would be used to mitigate worker doses. Therefore, the accident consequences for workers are also considered to be negligible.

The estimated doses and resultant health risks provided in the analysis of accidents are conservative. They are based on a bounding radiologic inventory for the experiments and a very conservative estimate of the TREAT Reactor core radiologic inventory. The dose calculations do not credit reductions in radionuclide concentrations that could occur during transport from the site of an accident to the outside environment. The estimated doses do not assume collocated workers or members of the public are evacuated. Facility workers and collocated workers are assumed to be unprotected by shielding, respirators, or other personal protective equipment. Workers are present in the TREAT Reactor Building during steady-state or low-power reactor operations. There are no credible reactor accident scenarios resulting in facility worker or collocated worker exposure from this mode of reactor operation. During transient testing, workers are located in the TREAT Reactor Control Building, about 0.45 miles southeast of the reactor building. Administrative controls and protective actions and equipment would be used to mitigate worker doses. Additional conservatism in the dose calculation are discussed for each accident, as applicable, in Appendix F, Schafer et al. (2013).

4.1.3 Impacts of Transportation

Transportation of the test assembly components in Alternative 1 would occur between facilities on the INL Site. The route that will be followed is shown in Figure 7, and is entirely on the INL site using roadways controlled by INL security. Transportation of research fuels to MFC from commercial facilities would occur on public roadways pursuant to the NRC's authority for the commercial reactor using commercial, NRC-certified, U.S. Department of Transportation (DOT)-compliant transport casks.

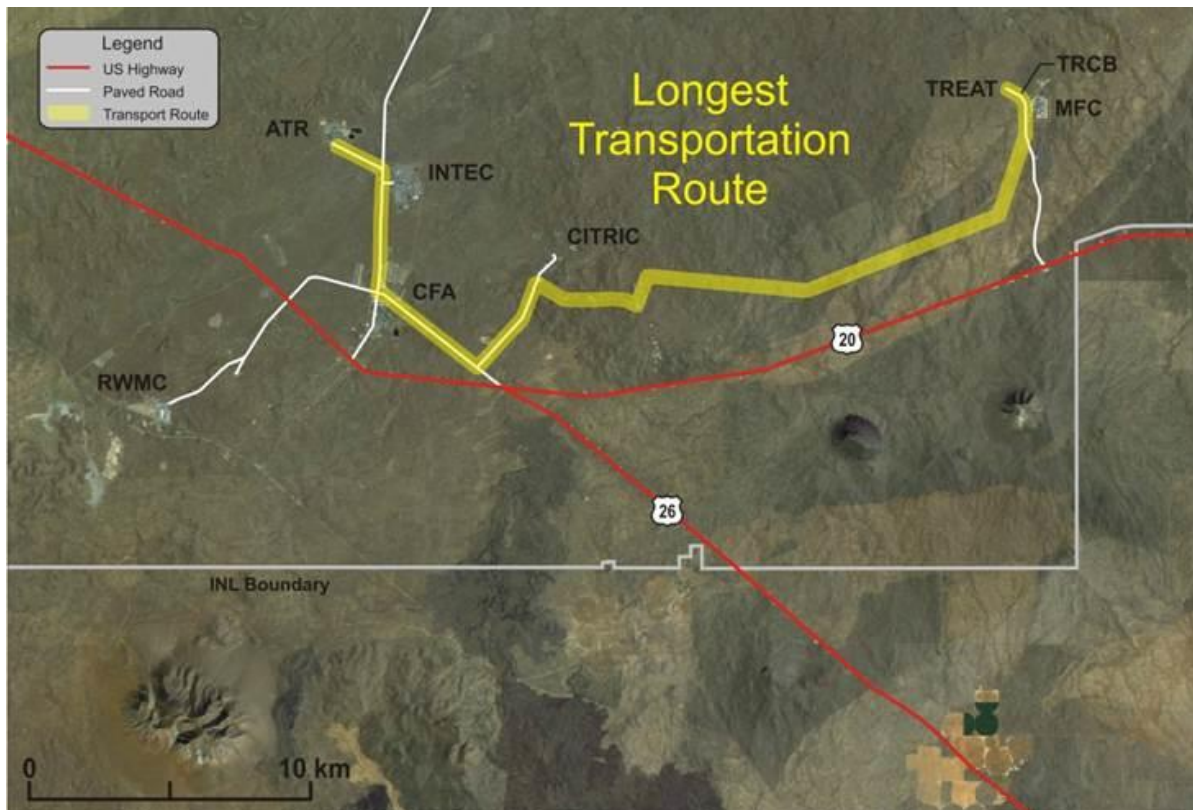


Figure 7. Longest transportation route that would be followed between INL facilities.

For transportation on the INL site, two types of casks would be used: a cask similar to the GE-2000 or Battelle Energy Alliance research reactor cask would be used for transportation to MFC and for transportation to TREAT, a cask specially designed to transport the MARK-III test assemblies (TREAT Loop Handling Cask HFEF-15 cask) would be used.

The assessment of transportation impacts considered all major groups of potentially exposed persons. Transportation associated with Alternative 1 would involve “out of commerce” shipments on roads located solely on the INL. As the test materials are being transported between facilities on the INL access to the route by members of the public and non-involved workers will be restricted and a transportation-related dose would not be received. Therefore, major groups of potentially exposed persons are reduced to:

- **Collocated workers along the route:** Collective doses are calculated for all persons working in the facilities at INL along each side of the transportation route. The width of this band is assumed to be approximately ½ mi.
- **Inspectors (see Glossary) of the transport:** Collective doses are calculated for workers that would inspect the transport initially and that could accompany the transport along the route. Inspectors are assumed to be occupational radiation workers, are shielded, and would be monitored by a dosimetry program. Therefore, the maximum allowable dose would be 5 rem/year (2 mrem/hour).
- **Crew members (see Glossary):** Collective doses are calculated for the truck transportation crew members. Truck crew members are assumed to be occupational radiation workers, are shielded, and would be monitored by a dosimetry program. Therefore, during routine transport, the maximum allowable dose would be 5 rem/year (2 mrem/hour) (DOE 1994).

Routine Transportation

The transportation doses expected during routine transport on INL computed for the longest possible route are shown in Table 3. These results are provided for 34 round trips and represent annual collective population doses.

Table 3. Summary of analysis results for routine transportation for 34 onsite round trips to TREAT.

Receptor	Dose (per year)	LCF ^a (per year)
Crew (Transportation Worker)	0.3 (person-rem)	1 chance in 5,500
Collocated Workers Along Route	0.04 (person-rem)	1 chance 42,000
Maximum Collocated Worker Dose	2.6×10^{-5} (rem)	1 chance in 64 Million
Inspector/Escort (3m from Cask)	0.6 (rem)	1 chance in 2,800

a. See definition in ‘Glossary’ or understanding LCF under ‘Helpful Information For the Reader’.

Transportation Accidents

On-site shipments containing radiological materials undergo an extensive safety analysis and review process to ensure proper safety plans are developed and implemented. After a review of the design criteria used for the shipping casks and of the potential transportation accident scenarios that could occur on INL, it was determined that an accident that would result in the release of radioactive material from a shipping cask is not credible (Schafer et al 2013). Accidents, including minor accidents, are not likely to occur more than once in every 100,000 miles on public roadways (NRC, 2012). Minor accidents are more unlikely to occur on INL because of the low transport speeds and because access along the INL transportation route will be restricted. The total number of miles traveled on INL per year is expected to be less than 1,000. Based on mileage alone, there is very little chance that even a minor accident would occur in any year.

Type B casks such as the General Electric-2000 or the Battelle Energy Alliance Research Reactor cask are licensed for highway speeds over public roads and certified to withstand a 9 m drop onto a solid surface with impact at the most damaging point followed by a 1 m drop onto a steel bar (10 CFR 71.73). To withstand a potential accident involving a fire, they are also designed to withstand an 800°C fire for 30 minutes. These design criteria are in place to minimize the release of radionuclides during potential traffic accidents.

The HFEF-15 cask has undergone an extensive safety analysis and review process to ensure it is capable of safely transporting the test loops between the HFEF and TREAT. It is designed to protect the MARK-III loops under credible drop or impact conditions. The route between MFC and TREAT will be controlled and access will be restricted during transport.

Non-Radiological Transportation Impacts

Non-radiological impacts related to transportation for Alternative 1 occur simply as any material is transported from one location to another independent of the characteristics of the cargo. Non-radiological risks are directly related to vehicle emissions (greenhouse gases [GHGs]) and the probability of accident related fatality. Table 4 identifies the transportation characteristics for Alternative 1 and applies documented rates of occurrence or risk factors as appropriate.

Table 4. Estimated annual emissions and fatalities resulting from on-Idaho National Laboratory shipments.

Impact Type	Factor	INL Transportation
Miles/Round Trip		25.2
Trips/Year		34
Distance/Year		860 mi
Gallons/Year	6.6 mi/gallon ^a	130
Greenhouse Gases	22.2 lb/gallon ^b	1.5 ton
Accident Fatality ^c	0	0

a. State Transportation Statistics, 2005.
b. www.eia.gov/tools/faqs/faq.cfm?id=307&t=11.
c. On INL, no accidents are anticipated and there would be no accident related fatalities.

4.1.4 Impacts of Intentional and Destructive Acts

Impacts of intentional acts of destruction occurring at an INL facility or during transport on INL were considered. The potential for an act of sabotage occurring on site is mitigated by protective services. INL routinely employs a variety of measures to mitigate the likelihood and consequences of intentional destructive acts. The DOE maintains a highly trained and equipped protective force intended to prevent attacks against and entry into the facilities. The site perimeters are monitored and patrolled to prevent unauthorized entry.

Access to INL roads will be restricted during transport of radioactive materials. Security measures will be in place to mitigate the likelihood and consequences of sabotage. Transportation crew members would be screened for behavioral and substance abuse issues and would receive safety and security training. Crew members would conduct a thorough inspection of their vehicle and load prior to transport. During transport, crew members would always have in their possession a working means of communication and would be trained to immediately report suspicious activity encountered en route.

An act of sabotage for Alternative 1 would result in dose consequences similar to the *bounding accident* (see Glossary) scenarios evaluated for TREAT.

4.1.5 Sustainability

Increases in diesel generator use, on-site transportation, and emissions from stationary combustion sources would result in an estimated 24 Metric Tons (MT) CO₂ equivalent GHG emissions every year. Purchased electricity to operate TREAT would also be a contributor of GHG emissions. Although an increase in power use at TREAT is likely to have some effect on INL's GHG emissions, it would be a very small part of INL's overall GHG inventory based on estimates of similar facilities and TREAT power needs. The GHG emissions at INL in fiscal year 2012 were about 140,000 MT CO₂ equivalents. The additional GHG produced by Alternative 1 represents less than 0.02% of the total INL GHG emissions.

4.1.6 Cumulative Impacts

DOE reviewed the resources at risk; their geographic boundaries; past, present, and reasonable foreseeable future actions; and baseline information in determining the significance of cumulative impacts. The review was assessed for construction, transportation, normal operations, and potential impacts of accidents. Conclusions are as follows:

- As a result of refurbishment activities, there would be no cumulative biologic or cultural resource impacts. New footprints would not be established. There would be low short-term impact to INL's ecological resources and no adverse impacts to historically significant buildings and structures. Given the nature of the impacts, cumulative effects are determined to be negligible.
- During normal operations, cumulative radiologic, waste generating, or sustainability impacts would be minimal. Radiologic releases during normal reactor operations, transport of test assembly components, and transient testing would not result in adverse health impacts. Additional waste volumes would be small compared to current disposal volumes at INL. Additional GHG emissions would be negligible compared to INL-wide amounts.

The potential additive impacts from implementing Alternative 1 for the Resumption of Transient Testing on the INL are determined to be collectively negligible and would have no impact to reasonably foreseeable actions.

4.2 Alternative 2 – Modify the ACRR

Alternative 2 involves pre-irradiation examination at INL's MFC, transportation of the test assembly components to SNL/NM, assembly of components in the ACRR hot cell, irradiation of the test assembly in the ACRR, repackaging for transport in the ACRR hot cell, transportation of the test assembly components back to INL for post-irradiation examination, and disposal of generated waste.

This EA considers construction and normal operations activities that will occur at ACRR, transport to SNL/NM from INL's MFC, transport on INL, and accidents that could occur either on INL or at SNL/NM. The detailed analyses of these impacts are contained in Schafer et al. (2013) and summarized in this EA.

4.2.1 Construction and Normal Operations Activities

Construction and normal operations activities for Alternative 2 are discussed in Section 2.2.2. Construction activities include building a new hot cell at ACRR and adding a fuel motion monitoring device to ACRR. This analysis evaluates the effects of putting in a hot cell to determine the potential to impact biologic, ecologic, and cultural resources.

Normal transient testing operations using ACRR involve the irradiation of the test assembly in the reactor, steady-state and transient operation of the reactor, transportation of the test assembly, and disposal of generated waste. The detailed analyses of radiologic impacts are contained in Schafer et al. (2013).

Understanding Normal ACRR Operations

During the sequence of events that would take place under normal operating conditions, the ACRR reactor is operated under steady-state and transient conditions and heat is generated in the reactor and test assembly. As previously described, the ACRR is water cooled. The cooling water entrains most fission and activation products in the pool water.

Releases to the Air

Non-Radiological Emissions—

The ACRR uses power supplied exclusively from the grid. It does not use diesel generators to provide supplementary power. Therefore, during normal reactor operations and during transient testing, only activated air surrounding and adjacent to the reactor would be released to the environment.

Radiologic Impacts of Atmospheric Releases—

ACRR is an operating reactor. ACRR is currently capable of limited transient testing. Therefore, this EA will only assess the incremental impact of conducting transient tests discussed in Sections 1 and 2 at ACRR. For the energy production required during the experiments, the annual projected emissions from the ACRR Stack for the proposed tests would be about 1.3 Ci of Ar-41. Atmospherically transported emissions were evaluated for the release of Ar-41 at the following three locations (see Figure 8) (Schafer et al. 2013).

1. **Kirtland Storage Site:** This location is occupied by workers 24 hours per day, seven days per week, and therefore represents an important worker location. It is the site most impacted by operations at ACRR. The total ED at this site from combined SNL/NM sources is 8.6×10^{-4} (0.00086) mrem/year. The ED contribution from transient testing would be 4.8×10^{-4} (0.00048) mrem/year.
2. **Chestnut Site:** This site is occupied by Air Force personnel workers. There are no permanent residents at Chestnut Site. The total ED at this site from combined SNL/NM sources is 8.2×10^{-4} (0.00082) mrem/year. The contribution from transient testing would be 1.1×10^{-4} (0.00011) mrem/year.
3. **Eubank Gate:** This is the closest location to ACRR frequently occupied by members of the public. The estimated ED from transient testing would be 4.8×10^{-5} (0.000048) mrem/year.

The EDs from normal operations at these locations are well below the 10 mrem/year federal standard set by 40 CFR 61, Subpart H – National Emissions Standards for Hazardous Air Pollutants. Cumulative doses from all SNL/NM sources and from air emitted from the ACRR will also be well below the 10 mrem/year dose standard.

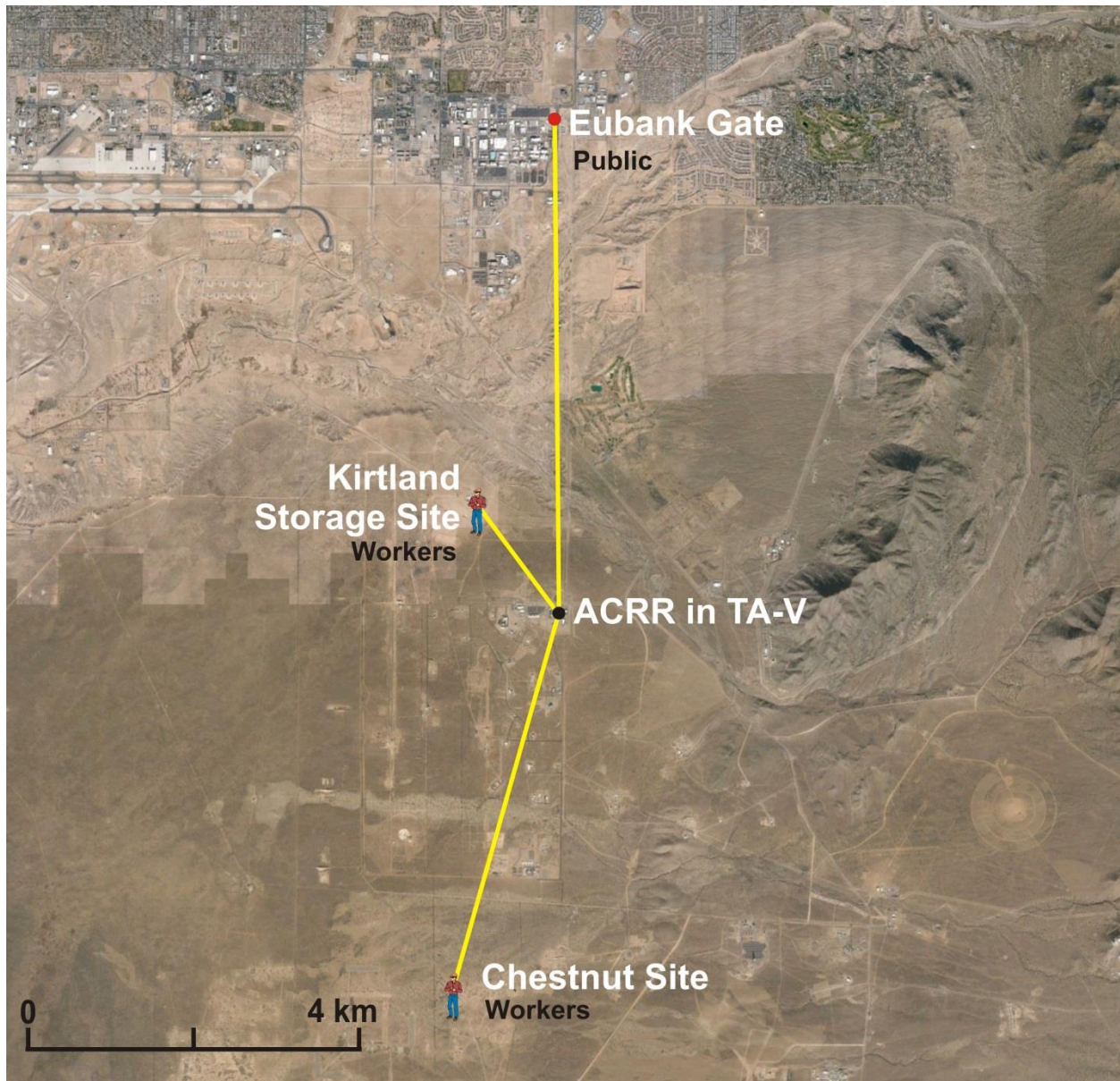


Figure 8. Receptor locations for the air pathway analysis, showing distance and direction from the Annular Core Research Reactor (ACRR) (Base map courtesy of Google Earth).

Radiological Impacts of Releases to Soils—

Atmospheric releases during normal operations from the ACRR are limited to Ar-41, a noble gas that is neither deposited on plant or soil surfaces nor subject to bioaccumulation by biota. Therefore, there are no ingestion or biotic exposure pathways from contaminated soil that need to be considered by this analysis.

Radiological Impacts to Groundwater—

Normal operations at ACRR do not result in releases of radionuclides to soil or groundwater. Therefore, there are no groundwater pathways that need to be considered by this analysis.

Impacts to Biological Resources

Potential impacts to biologic resources would consist of those resulting from pre-operations construction disturbances.

Plants and Soil Disturbance Impacts—

TA-V is a developed area. Construction impacts would be limited to areas within TA-V. Impacts to biological resources would be short-term, occurring during construction.

Wildlife Impacts—

Two major physiographic provinces influence the flora and fauna of the region: (1) Mesa and plains and (2) Mountains (SNL/NM, 2012). The topography of the KAFB and SNL/NM area ranges from lowland grasslands to high-elevation coniferous forests. With much of the area undeveloped, there is great diversity in plant and animal communities within the KAFB and SNL/NM area. At least 267 plant species, 206 bird species, 34 reptile/amphibian species, 25 small mammal species, 2 ungulate species (KAFB, 2007), 13 bat species (KAFB, 2009), and 13 predator species (KAFB, 2006) have been documented on KAFB. There are 25 species that are either federal or state listed as: threatened or endangered, candidate, or species of concern, occurring in Bernalillo County (SNL/NM, 2012).

Construction and operation of the ACRR for transient testing would not result in increased disturbance to the already developed industrial setting and would have negligible impacts on local wildlife and plant species.

Radiological Impacts to Plants and Animals—

The only radionuclide released during normal operations (including the transient tests), is airborne Ar-41. Argon-41 does not form particulates, and therefore is not subject to ingestion. Accordingly, the dose from radiological emissions to biota would be negligible.

Impacts to Cultural Resources

The proposed new hot cell footprint would pose no threat to cultural resources. Although the area includes contributing elements to a proposed historic district, the purpose and design of the new hot cell are in keeping with the functions of the existing buildings in the area. Archaeological surveys in SNL/NM's TA-V indicated the ground has been previously disturbed and revealed no archaeological sites or the likelihood of them. Should construction reveal any archaeological remains, work would be stopped and the site would be assessed appropriately (Ullrich, R. A., et al., 2010a and b and 2012).

Impacts of Waste Generation and Management

Waste would be generated at SNL/NM during construction activities in TA-V, during modification of ACRR to accept the fuel motion monitoring device, and when handling the experiments in the ACRR hot cell. Alternative 2 would also use the facilities at INL, with most waste generation occurring at MFC where pre- and post-irradiation examination of the test assembly components would be conducted. The final disposition of waste associated with the test assemblies would occur at INL.

Modification of ACRR and Construction of New Hot Cell—

Wastes and effluents generated during hot cell construction are expected to be of standard industrial types and quantities. Installing a fuel motion monitoring device into ACRR can be accomplished in the current facility and is not expected to result in significant impact. Wastes generated would include normal construction debris and sanitary wastewater such as wood crates, cardboard, plastic, and concrete. Recyclable material would be separated, and the remaining

waste transported to the KAFB landfill or other appropriate construction waste landfills for disposal. Less than 765 m³ of waste is expected to require disposal.

No radioactive waste is anticipated to be generated during modification and construction. If radioactive waste were generated, it would be accumulated and stored in accordance with federal and state regulations, treated if required, and disposed at an off-site permitted facility.

Routine Maintenance and Operations at ACRR and New Hot Cell—

LLW would be generated during unpackaging and preparation of the test assembly in the hot cell, during decontamination of the irradiated test assembly, and during disassembly and packaging of the test assembly and any associated materials into DOT-approved casks for transport to the MFC facilities at INL. MLLW may also be generated during these operations. These wastes are expected to be similar to wastes generated during current reactor operations at SNL/NM; such wastes include used personal protective equipment, filters, and other debris. LLW and MLLW would be managed in accordance with existing waste management procedures at SNL/NM prior to off-site treatment or disposal. MLLW requiring treatment in accordance with Federal and state regulations would be treated using on-site treatment capabilities or shipped off-site for treatment at a permitted commercial facility prior to off-site disposal at a facility permitted to accept the waste. The operations would result in the generation of less than 2 m³ LLW and MLLW per year. During the past three years, SNL/NM sent an average of 69 m³ LLW and treated MLLW to off-site facilities for disposal each year. The additional waste requiring disposal due to these operations would represent less than a 3% increase in the volume sent to off-site disposal facilities each year. The environmental impacts associated with management of LLW and MLLW at SNL/NM were evaluated in the 1999 Site-Wide Environmental Impact Statement for SNL/NM (DOE/EIS-0281).

Experiment Handling and Examination at INL Facilities—

In Alternative 2, pre- and post-irradiation examination of transient testing experiments would be performed at INL MFC facilities. INL would manage LLW and MLLW generated by post-irradiation examination in accordance with DOE policies and procedures.

The projected waste streams generated at MFC would be the same as in Alternative 1. Estimates for the amount and types of radioactive waste generated under Alternative 2 at MFC would be equal to those generated under Alternative 1 plus the amount that would be generated during packaging and receipt of waste from SNL/NM.

In Alternative 2, DOE estimates that the volume of radioactive waste generated is approximately the same as generated in Alternative 1 and that the total increase in waste generation would have negligible environmental impacts at either site in this alternative.

4.2.2 Accident Consequences

Accident consequences for Alternative 2 were evaluated for events related to test assembly and material handling operations at INL, test assembly and material handling operations at SNL/NM, and irradiation of the test assembly in the ACRR (Schafer et al. 2013). Transportation impacts are discussed in Section 4.2.3. The analysis generally followed the approach used for accidents at INL (summarized in Section 4.1.2). The analysis was conducted by:

1. Using the test assembly radiologic inventory identified for Alternative 1 (i.e., the bounding inventory) and identifying the ACRR radiologic inventory that poses the highest dose potential.
2. Identifying potential accident scenarios that could involve handling the test assembly at INL, handling the test assembly at SNL/NM, and irradiating the test assembly in ACRR.

3. Calculating the annual frequency of occurrence for each accident scenario and calculating the probability of each accident scenario occurring during the 40 year Resumption of Transient Testing program lifetime.
4. Identifying receptor locations for dose calculations. Receptor locations included those for facility workers, collocated workers and members of the public. These receptor locations are in Idaho for accidents that could occur on INL and in New Mexico for accidents that could occur at SNL/NM.
5. Calculating the doses for each receptor and numbers of estimated cancer fatalities that could result from the dose (LCF).

Radiologic Consequences

The results of the highest consequence events expected to occur either at INL or SNL/NM are shown in Table 5. The consequences of these events can be summarized as follows:

- **Accidents at INL.** Accidents occurring at INL under Alternative 2 are most likely to result from fuel handling operations at HFEF. Mechanical damage could be caused by equipment failure or by operator error. There is one chance in 200 in any given year that a mishandling event severe enough to result in a release of radiologic material would occur. There is one chance in 5 that this type of accident would occur once during the 40 year program lifetime.
- **Accidents at SNL/NM.** The worst-case plausible accident at SNL/NM would occur if the test assembly failed while in the ACRR central cavity. The engineering design requirements of an experiment assembly make it unlikely that a failure would occur. There is one chance in 500 that a test assembly would fail in any given year. There is one chance in 12 that this type of accident would occur once during the 40 year program lifetime.

As a result of these accidents, consequences for members of the public and for collocated workers would be negligible without additional protective measures. Administrative controls and protective actions and equipment would be used to mitigate worker doses. Administrative procedures that could be implemented at ACRR have not been factored into the dose estimates provided in Table 5.

The estimated doses and resultant health risks provided in this analysis are conservative. They are based on a bounding radiologic inventory for the experiments. The estimated doses assume receptors are evacuated after 2 hours. Facility workers and collocated workers are assumed to be unprotected by shielding, respirators, or other personal protective equipment. Additional assumptions made in the dose calculation are discussed for each accident as applicable in Appendix F, Schafer et al. (2013).

Table 5. Summary of dose impacts for highest consequence events for Alternative 2.

Receptor	Dose	LCF ^a
Accidents at INL		
Facility Worker ^b	3 rem/min	NA ^c
HFEF Collocated Worker	0.1 rem	1 chance in 17,000
Offsite Member of the Public	0.007 rem	1 chance in 240,000
Worst case accident at SNL/NM		
Facility Worker ^b	75 rem/min	NA ^c
ACRR Collocated Worker	4 rem	1 chance in 410
Offsite Member of the Public	0.4 rem	1 chance in 4,200
<p>a. See definition in 'Glossary' or understanding LCF under 'Helpful Information For the Reader'</p> <p>b. Facility worker doses do not credit protective actions or equipment. Administrative controls and protective actions and equipment would be used to mitigate worker doses</p> <p>c. Administrative controls and protective actions and equipment would be used to mitigate facility worker doses. Therefore, no LCF are anticipated.</p>		

4.2.3 Impacts of Transportation

Transportation on INL for Alternative 2 would impose the same restrictions for non-involved workers and members of the public. The route would exclude the route segment between MFC and TREAT; this route segment is short relative to the total route length and passes fewer facilities. Therefore, the impacts of transportation on the INL for Alternative 2 are approximately equal to those presented in Section 4.1.3.

Transportation between INL and ACRR is discussed below. Transportation impacts between INL and ACRR were analyzed along two routes running between INL and ACRR: the most direct route, which goes through Idaho, Utah, Colorado, and New Mexico; and a longer route, which goes through Idaho, Wyoming and Colorado, bypassing Utah (see Figure 9). For routine transportation, all major groups of potentially exposed persons were considered. They include the following population groups:

- Persons along the route
- Persons at stops
- Vehicle occupants sharing the route
- Crew members.

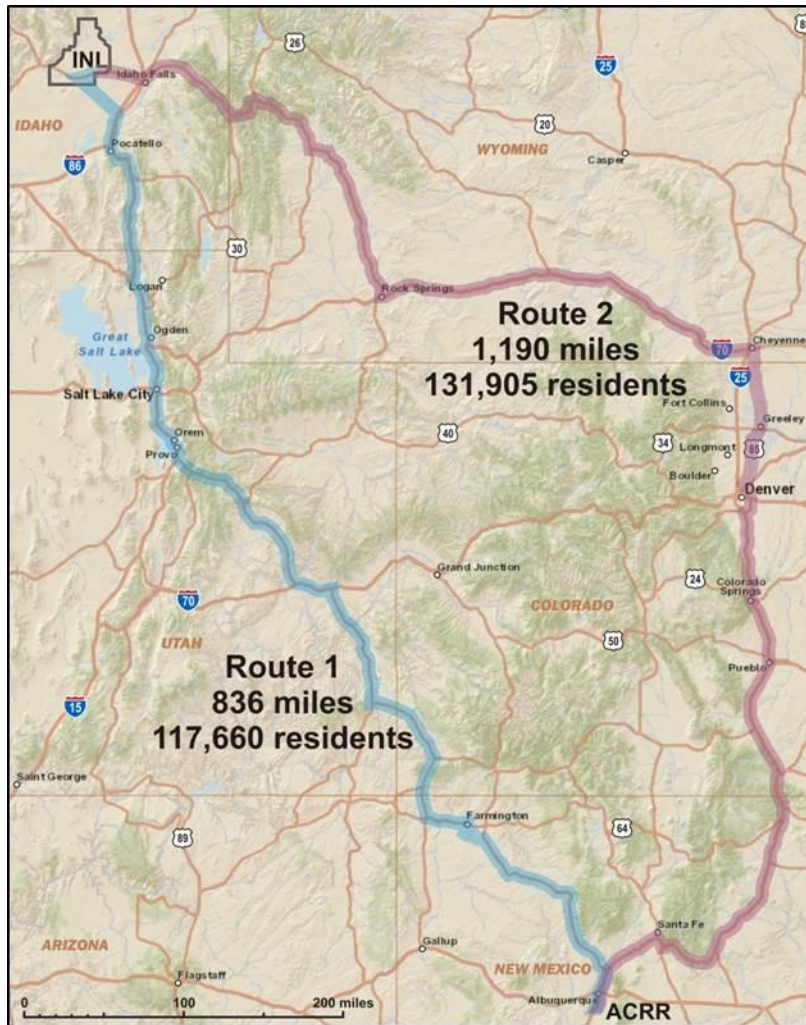


Figure 9. Map of transportation routes evaluated between the INL and ACRR.

Routine Transportation

For Alternative 2, the routine transportation impacts include those shown in Table 3 for transport on INL and in Table 7 for transport from INL to ACRR. Transportation of test assembly components to ACRR from INL would use commercially available, NRC-certified, DOT-approved transportation casks. The values shown in Table 6 represent the maximum exposure occurring on any segment of the two transport routes. The values shown represent cumulative doses and LCFs for 34 roundtrip shipments from INL to ACRR; therefore, they represent an annual dose.

Table 6. Summary of annual routine transportation dose impacts for transport between the INL and ACRR.

Receptor	Dose (person-rem)	LCF ^a
Crew	11	1 chance in 150
Population Along Route (residents)	0.1	1 chance in 16,700
Vehicle Occupants Sharing Route	1.5	1 chance in 1,100
Persons at a Stop	0.5	1 chance in 3,300

a. See definition in 'Glossary' or understanding LCF under 'Helpful Information For the Reader'.

Transportation Accidents

Transportation accidents severe enough to result in the release of radioactive materials on INL are not credible. As discussed in Section 4.1.3, the type of cask that will be used, limited miles traveled per year, and the ability to restrict access to the transportation corridor all combine to make transportation accidents extremely unlikely.

The different types of accidents that can interfere with routine transportation of radioactive materials on public roadways between INL and SNL/NM are as follows:

- Accidents in which the transportation cask is not damaged or affected. The probability of this type of accident is on the order of 1 in 10,000. These include:
 - Minor traffic accidents (e.g., fender-benders or flat tires), resulting in minor damage to the vehicle
 - Accidents that damage the vehicle or trailer enough so that the vehicle cannot move from the scene of the accident under its own power, but do not result in damage to the cask
 - Accidents involving a death or injury, or both, but do not result in damage to the cask.
- Accidents in which the cask is affected. The probability of an accident resulting in a release of radiologic material from the DOT approved Type B casks is on the order of 1 in 10¹⁰. These include:
 - Accidents resulting in the loss of lead gamma shielding or neutron shielding (or both), but no radioactive material is released
 - Accidents in which radioactive material is released.

Results of the transportation accident analysis are provided in Table 7. Because of the robust design of the Type B cask that will be used for interstate transport, the resulting doses for both types of accidents are negligible.

Table 7. Summary of transportation accident dose impacts for Alternative 2 transport between INL and ACRR.

Impact Types	Accident Not Involving a Release from the Cask or Loss of the Lead Shield		Accident Involving a Release	
	Person-rem	LCF ^a	Person-rem	LCF
Overall Maximum Dose per Accident	1.7×10^{-2}	1 chance in 98,000	2.8×10^{-1}	1 chance in 6,000
Overall Maximum Dose Risk per Accident	1.0×10^{-6}	1 chance in 2 Billion	1.2×10^{-14}	1 chance in 144 Quadrillion

a. See definition in 'Glossary' or understanding LCF under 'Helpful Information For the Reader'.

Non-Radiological Transportation Impacts

Non-radiological impacts related to transportation for Alternative 2 include those that could occur on INL and those that could occur between INL and ACRR. Non-radiological impacts are directly related to vehicle emissions (GHGs) and the probability of accident related fatalities. Table 8 identifies the transportation characteristics and consequences for the onsite and offsite transport route segments. For Alternative 2, the total impact includes impacts occurring on INL added to the impact occurring between INL and ACRR.

Table 8. Summary of annual emissions and accident fatalities for Alternative 2.

Impact Type	Factor	Route 1	Route 2
Total Miles/Round Trip ¹		2,720	3,853
Trips/Year		34	34
Total Distance/Year		92,400 mi 149,000 km	131,000 mi 211,000 km
Total Gallons/Year	6.6 mi/gallon ²	13,900	20,000
Total Greenhouse Gases	22.2 lb/gallon ³	155 T	220 T
Accident Fatalities between INL and ACRR	3.53×10^{-3} fatalities/accident	1.3×10^{-5}	2.3×10^{-5}
Accident Fatalities on INL ⁴	0 accidents	0	0
Total Accident Fatalities		1.3×10^{-5}	2.3×10^{-5}

1. Total miles per round trip includes 25.2 miles associated with onsite transportation at INL. Between INL and SNL/NM, there are 1346.5 miles on Route 1, and 1914 miles on Route 2; distances are based on transportation routing for hazardous material and are therefore longer than those shown in Figure 6.
2. State Transportation Statistics, 2005.
3. www.eia.gov/tools/faqs/faq.cfm?id=307&t=11.
4. On INL no accidents are expected to occur.

4.2.4 Impacts of Intentional and Destructive Acts

Impacts of an intentional destructive act on INL were considered in Section 4.1.4. The potential for an act of sabotage occurring at SNL/NM will be mitigated by protective services. SNL/NM routinely employs a variety of measures to mitigate the likelihood and consequences of intentional destructive acts. The DOE maintains a highly trained and equipped protective force intended to prevent attacks against and entry into the facilities. Access to facilities on SNL/NM is controlled, with only those persons performing official business and presenting the proper credentials being allowed onsite. The site perimeters are monitored and patrolled to prevent unauthorized entry.

Transport of radioactive materials would routinely employ a variety of measures to mitigate the likelihood and consequences of sabotage. Crew members would be screened for behavioral and substance abuse issues and would receive safety and security training. Crew members would conduct a thorough inspection of their vehicle and load prior to transport. During transport, crew members would always have in their possession a working means of communication and would be trained to immediately report suspicious activity encountered en route.

4.2.5 Sustainability

The ACRR uses power supplied exclusively from the grid. Although an increase in power use at the ACRR is likely to have some effect on SNL/NM's GHG emissions, it would continue to be a very small part of SNL/NM's overall GHG inventory. SNL/NM's ongoing site-wide initiatives for reductions in energy intensity would continue on the path of reducing overall electricity purchases.

Sustainability impacts related to transportation are provided in Section 4.2.3. Alternative 2 would consume between 54,400 and 77,000 gallons of fuel per year, depending on the route followed. This would generate between 84 and 118 MT of GHGs. The additional GHG produced during operations at ACRR would have minimal impact on the SNL/NM GHG reduction goal established by SNL/NM's Site Sustainability Plan (SSP). However, increased use of electricity during operations at ACRR may impact SNL/NM's SSP energy intensity reduction goal.

4.2.6 Cumulative Impacts

Cumulative effects for the Resumption of Transient Testing activities conducted under Alternative 2 must consider those that could occur at INL, those enroute to SNL/NM, and those that could occur at SNL/NM. The ACRR is an operational facility; and therefore, cumulative impacts

must consider current operations. DOE reviewed the resources at risk. The review was assessed for construction, normal operations, potential impacts of accidents, and potential impacts outside immediate facility areas. Conclusions are as follows:

- As a result of building the new hot cell at ACRR, there would be a slight increase in building footprint. The impacts of the construction on resources would be minimal because the new hot cell would be constructed on an already disturbed area within TA-V.
- During operations, there would be no significant cumulative radiological or waste generating impacts. Radiologic impacts during normal reactor operations, transport of test assembly components, and transient testing would not result in adverse health impacts and the likelihood of LCF occurrence is extremely low. Additional waste generation during normal operations is small compared to current disposal volumes at INL and SNL/NM. Sustainability impacts are disperse and associated with transportation. Additional GHG emissions that could occur on INL or SNL/NM are negligible compared to site-wide amounts. Additional GHG emissions that would occur along the transportation route from INL to SNL/NM would be additive to the location at which they occurred.

4.3 Alternative 3 – No Action

No action would mean that none of the impacts described in Alternative 1 or Alternative 2 would occur. DOE would have to rely on sites (domestic and international) that already carry out limited transient testing activities, which would not meet DOE's purpose and need as described in Section 1 or the criteria described in Section 2.1. The environmental impacts occurring at sites currently conducting transient testing would not change.

4.4 Summary of Environmental Impacts

A summary of impacts to wildlife resources, cultural resources, human health, waste management, and sustainability goals are summarized in Table 9. These impact statements are generalizations summarized from the analyses presented in Sections 4.1 and 4.2. The assessment of impacts for both action alternatives were conducted using similar evaluation approaches and criteria. Assessment of wildlife resources and cultural resources included a review of historical data and site-specific surveys where applicable. Computer codes and evaluation processes applied to assess atmospheric impacts for both alternatives were parameterized with site-specific data, and results are comparable to annual reports generated at INL and SNL/NM in compliance with 40 CFR 61 Subpart H. The analysis of dose consequences resulting from accidents adopted slightly different approaches based on differences in the reactors that would be used by each Alternative. Scenarios identified for both alternatives provide the bounding dose consequences. Differences in the dose assessment approaches were determined to be acceptable and appropriate. The dose assessment approach applied for each scenario is conservative and resultant doses should be viewed as upper-bound screening-level values. Therefore, the summary of impacts assessed in this EA and summarized in Table 9 provides a reasonable basis for comparison between the analyzed alternatives. Based on the analysis provided in this EA, potential impacts from either alternative would be small.

Table 9. Summary of environmental impacts.^a

Resource	Alternative #1 Restart the TREAT Reactor (Preferred Alternative)	Alternative #2 Modify ACRR
Impacts – Normal Operations		
Non-Radiologic Atmospheric Impacts – chemical pollutants	<ul style="list-style-type: none"> Annual cumulative diesel fuel usage for the two generators is estimated at 2,500 gallons. The diesel generator fuel consumption at TREAT would represent a small percentage of INL diesel use and resultant emissions. 	None
Atmospheric Pathway	<ul style="list-style-type: none"> The cumulative INL-wide air emissions dose at Frenchman's Cabin is about 3.68×10^{-2} mrem/year, equal to about 0.37% of the 10 mrem/year dose limit The estimated ED for the closet public receptor (at Atomic City) is about 2.1×10^{-3} mrem/year, equal to about 0.02% of the 10-mrem/year dose limit The ED for the nearest worker (at the TREAT Reactor Control Building) is 3.6×10^{-3} mrem/year, equal to about 0.04% of the 10-mrem/year dose limit. 	<ul style="list-style-type: none"> The estimated ED for the public receptor (at the Eubank Gate) is about 4.8×10^{-5} mrem/year, is less than 0.0005% of the 10-mrem/year dose limit The cumulative SNL/NM air emissions dose at the Kirtland Storage Site, affecting workers, is about 8.6×10^{-4} mrem/year, equal to about 0.01% of the 10-mrem/year dose limit The cumulative SNL/NM air emissions dose (at the Chestnut Site), affecting workers, is about 8.2×10^{-4} mrem/year, equal to about 0.01% of the 10-mrem/year dose limit.
Soil/Surface Pathway	<ul style="list-style-type: none"> The potential for exposure via contaminated soils is negligible based on a review of historical data and projected particulate releases. 	<ul style="list-style-type: none"> Since the only emissions from the tests (which are similar to the tests already conducted at the ACRR) would be gaseous Ar-41 (a noble gas), there would be no environmental exposures via the soil pathway.
Groundwater Pathway	<ul style="list-style-type: none"> Radionuclide transport from potentially contaminated soils is improbable given the short half-lives of the TREAT Stack effluents and the distance to the aquifer. 	<ul style="list-style-type: none"> Since the only emissions from the tests would be gaseous Ar-41, there would be no environmental exposures via the groundwater pathway.

Resource	Alternative #1 Restart the TREAT Reactor (Preferred Alternative)	Alternative #2 Modify ACRR
Biological Resources	<ul style="list-style-type: none"> • Impacts to biological resources would be short-term, occurring during refurbishment and replacement activities • No impact to federally listed endangered or threatened species would occur • Dose from radiological emissions to biota at the INL from the proposed transient tests are negligible • No direct impact to species of ethnobotanical (plants used by indigenous cultures) concern or to sensitive species would occur, as there are none present near TREAT or along the cable corridor. 	<ul style="list-style-type: none"> • Impacts to biological resources would be short-term, occurring during construction • There are no federally listed endangered or threatened plant or animal species present in TA-V • Dose from radiological emissions to biota at the ACRR from the proposed transient tests are negligible.
Cultural Resources	<ul style="list-style-type: none"> • There would be no direct impact to archaeological or tribally important resources from refurbishment and replacement activities and minimal potential indirect impacts to archaeological resources • No visual impacts from refurbishment/replacement or operational activities would occur • No adverse effects to historic structures would occur. 	<ul style="list-style-type: none"> • Little, if any, impact to cultural or historic resources would occur within TA-V; the ground is previously disturbed and the likelihood of archaeological sites is low.
Waste Generation	<ul style="list-style-type: none"> • The estimated LLW generated during refurbishment would be less than 100 m³, about 7.7% of INL's annual LLW disposed of off-site • TREAT will likely generate less than 2,000 gallons of wastewater annually, accounting for 0.04% of MFC's annual waste water • LLW generated during routine operations at TREAT are expected to represent less than 3.3% increase annually • The waste generated from pre- and post-examination, experiment packing, and routine handling would be about 5.5 m³ per year and represents less than 1% of the volume of radioactive and radioactive mixed waste generated at the INL each year. Transient testing activities would generate an estimated 6 m³ of transuranic waste, greater-than-class C (GTCC) waste, GTCC-like waste, or Spent Nuclear Fuel debris over the 40 year life of the program. 	<ul style="list-style-type: none"> • The estimated waste from modifying and constructing ACRR would be 765 m³ • The additional waste from routine maintenance and operations from transient testing would represent an increase of 3.0% LLW generation • The waste generated at the INL as a result of doing transient testing at ACRR would be approximately the same as INL. <p>Note: Waste from experiment and handling would occur at MFC under this alternative (see description on the left).</p>

Resource	Alternative #1 Restart the TREAT Reactor (Preferred Alternative)	Alternative #2 Modify ACRR
Impacts – Potential Accidents		
	<ul style="list-style-type: none"> • Highest consequence events that could affect workers have one chance in 25,000 of occurring in any given year. <ul style="list-style-type: none"> ○ Doses for collocated workers would be 7 rem and would result in 4×10^{-3} (or 1 chance in 240) LCF ○ The dose-rate for facility workers not protected by administrative controls or equipment would be 6 rem/min. Doses for facility workers would be mitigated by administrative procedures and use of protective equipment. • Highest consequence events that could affect members of the public have one chance in 270,000 of occurring in any given year <ul style="list-style-type: none"> ○ Doses to members of the public would be about 0.2 rem, and would result in 1.4×10^{-4} (or 1 chance in 8,300) LCF. 	<ul style="list-style-type: none"> • Highest consequence events that could occur for pre-test and post-test examinations at INL have one chance in 200 of occurring in any given year. <ul style="list-style-type: none"> ○ Doses for collocated workers would be 0.1 rem and would result in 5.9×10^{-5} (or 1 chance in 17,000) LCF ○ The dose-rate for facility workers not protected by administrative controls or equipment would be 3 rem/min. Doses for facility workers would be mitigated by administrative procedures and use of protective equipment. ○ Doses to members of the public would be 0.007 rem, and would result in 4.2×10^{-6} (or 1 chance in 240,000) LCF. • Highest consequence event that would occur for pre-test, post-test, and irradiation activities at SNL/NM have one chance in 500 of occurring in any given year. <ul style="list-style-type: none"> ○ Doses for collocated workers would be 4 rem and would result in 2.4×10^{-3} (or 1 chance in 410) LCF ○ The dose-rate for facility workers not protected by administrative controls or equipment would be 75 rem/min. Protective equipment and administrative procedures would be used to limit worker doses, allowing them to safely evacuate the building before significant exposure. ○ Doses to members of the public would be 0.4 rem, and would result in 2.4×10^{-4} (1 chance in 4,200) LCF

Resource	Alternative #1 Restart the TREAT Reactor (Preferred Alternative)	Alternative #2 Modify ACRR
Impacts -- Transportation		
	<ul style="list-style-type: none"> • Transportation accidents on INL severe enough to result in a release from the transportation casks are improbable. 	<ul style="list-style-type: none"> • Transportation accidents in Alternative 2 would be limited to those occurring on the roadway between INL and SNL/NM • Accidents would result in doses less than 0.3 person-rem, and fewer than 2×10^{-4} (1 chance in 6,000) LCF and are therefore considered negligible.
Intentional and Destructive Acts		
	<ul style="list-style-type: none"> • Intentional destructive acts would result in doses bounded by scenarios considered in the accident analysis • Resultant health impacts to members of the public would be minimal. Resultant health impacts to workers would be mitigated by normal response actions and would also be minimal. 	<ul style="list-style-type: none"> • Intentional destructive acts involving the test components would be bounded by scenarios considered in the accident analysis and analysis of transportation accidents • Resultant health impacts to members of the public would be minimal. Resultant health impacts to workers would be mitigated by normal response actions and would also be minimal.
Sustainability		
	<ul style="list-style-type: none"> • Increases in diesel generator use, transportation, and emissions from stationary combustion sources would result in an estimated 24 MT CO₂ equivalent GHG emissions; total yearly scope 1 and 2 at the INL were 140,000 MT CO₂ equivalents GHG in fiscal year 2012 • Increase would not impact the INL GHG reduction goals. 	<ul style="list-style-type: none"> • Although an increase in power use at the ACRR is likely to have some effect on SNL/NM's Scope 2 GHG emissions, it would continue to be a very small part of SNL/NM's overall GHG inventory.
<p>a. Alternative #3 'No Action' results in no change to environmental impact from current operational activities at domestic and international activities conducting transient testing.</p>		

5 PERMITS AND REGULATORY REQUIREMENTS

Each alternative would be required to adhere to federal, state, and local regulations and obtain appropriate permits before constructing, modifying, or operating facilities, equipment, or processes. Below is a list of federal, state, and local regulations and permits that either of the alternatives may be required to adhere to or to obtain. DOE would be responsible for identifying a comprehensive list of applicable regulations and permits for the selected actions. Activities that affect, or may affect, the safety of DOE nuclear facilities must also comply with the requirements of 10 CFR 830, *Nuclear Safety Management*.

Air, Soil, and Groundwater

- DOE would need to obtain EPA's approval to restart the TREAT Reactor (40 CFR 61.05(a)). (Applies to Alternative 1).
- Diesel generator emissions are regulated by the EPA's Clean Air Act Requirements. If resuming transient testing using TREAT is selected as a result of the NEPA process, the diesel generators put in use will meet all applicable regulatory requirements before beginning operations. (Applies to Alternative 1).
- Radiologic air emissions must meet the EPA limit of 10 mrem/year for demonstration of compliance with "National Environmental Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities" (40 CFR 61, Subpart H). (Applies to Alternatives 1 and 2).

Biological

- Soil and vegetation disturbing activities, including those associated with mowing, blading, and mechanically removing vegetation, have the potential to increase noxious weeds and invasive plant species that would be managed according to 7 USC § 2814, "Management of Undesirable Plants on Federal Lands" and Executive Order 13112, "Invasive Species." INL would follow the applicable requirements to manage undesirable plants. (Applies to Alternatives 1 and 2).
- In analyzing the potential ecological impacts of the action alternative for this program, DOE-ID has followed the requirements of the Endangered Species Act (16 USC §1531 et seq.) and has reviewed the most current lists for threatened and endangered plant and animal species. Other federal laws that could apply include: the Fish and Wildlife Coordination Act (16 USC § 661 et seq.), Bald Eagle Protection Act (16 USC § 668), and the Migratory Bird Treaty Act (16 USC § 715-715s). (Applies to Alternatives 1 and 2).

Cultural

- Cultural resources are managed at the INL Site according to a tailored approach outlined in the INL Cultural Resource Management Plan (DOE-ID 2013b) and corresponding Programmatic Agreement executed among DOE-ID, the Idaho State Historic Preservation Office, and the Advisory Council on Historic Preservation. Shoshone-Bannock tribal interests in INL resources and activities are addressed in an Agreement in Principle between DOE-ID and the Shoshone-Bannock Tribes. INL would comply with the NHPA, Section 106, through transmittal of the 2013 Cultural Resource Investigations report for the proposed restart of the TREAT Reactor (Pace and Williams 2013) and the draft EA to the Idaho State Historic Preservation Office and the Shoshone-Bannock Tribes to initiate formal consultation on the program. (Applies to Alternative 1).

- Cultural resources at SNL/NM are managed through the NEPA Program. Properties are assessed by the Corporate History Program as changes (modifications or demolition) are proposed. Resulting recommendations are submitted to the Sandia Field Office for review and determination, and if necessary, consultation with the New Mexico State Historic Preservation Officer, in compliance with Section 106 of the NHPA. In 2010, a complete historic building survey and assessment was undertaken for the SNL/NM site to support DOE compliance with Section 110 of the NHPA (Ullrich, R. A., et al., 2010a and 2010b). In 2013, the survey and assessment were reviewed and updated based on the results of consultations between SFO and the New Mexico State Historic Preservation Officer on individual building renovations and demolitions, as well as changes in the built environment.
- SNL/NM TA-V was included in the 2010 SNL/NM survey and assessment, with the resulting recommendation that nine buildings in the area are potentially eligible for the NRHP as a historic district. Although consultation on the 2010 survey is not complete, the evaluation of the impact of Alternative 2 proceeded as though the buildings had already been found eligible. Archaeological surveys in SNL/NM's TA-V indicated the ground has been previously disturbed and revealed no archaeological sites or the likelihood of them. Should construction reveal any archaeological remains, work would be stopped and the site assessed appropriately (Ullrich, R.A., et al., 2010a and 2010b and 2012). (Applies to Alternative 2).
- Section 106 of the NHPA directs any federal agency undertaking or licensing any activity, to "prior to the approval of the expenditure of any federal funds on the undertaking or prior to the issuance of any license, as the case may be,[to] take into account the effect of the undertaking on any district, site, building, structure or object that is included in or eligible for inclusion in the National Register." In order to assess the impact of such an undertaking, an agency must know whether any affected district, site, building, structure, or object is eligible for the NRHP. (Applies to Alternatives 1 and 2).
- Section 110 of the NHPA requires a federal agency to assume responsibility for historic properties it owns or controls. Historic properties must be identified, evaluated, documented, and nominated to the NRHP, if appropriate. Thus, Section 110 obliges an agency to preserve its historic properties and manage those properties in compliance with Section 106—that is, if something the agency is going to do or authorize to be done would have a potential impact on a property that is on, or eligible for, the NRHP, the agency must engage in consultation regarding that impact. (Applies to Alternatives 1 and 2).

Sustainability

- Executive Order 13514 "Federal Leadership in Environmental, Energy, and Economic Performance:" DOE's 2012 Strategic Sustainability Performance Plan; and DOE Order 436.1, "Departmental Sustainability" provide requirements and assign responsibilities for managing sustainability within DOE to ensure that missions are carried out in a sustainable manner. These requirements also include provisions to institute wholesale cultural change to factor sustainability and GHG reductions into all DOE decisions, and to ensure that DOE achieves the sustainability goals established in its Strategic Sustainability Performance Plan. (Applies to Alternatives 1 and 2).
- In accordance with DOE's 2012 Strategic Sustainability Performance Plan Goal 2.5, alterations or renovations of existing buildings greater than 5,000 GSF must comply with the Guiding Principles. There are 26 Guiding Principles required for a building to meet compliance. Some are at no cost (e.g., non-smoking policy) and others require investments (e.g., water, gas, electricity meter installations). These requirements would be incorporated and addressed, where applicable. (Applies to Alternatives 1 and 2).

Nuclear Safety

- 10 CFR 830 establishes requirements that must be implemented in a manner that provides reasonable assurance of adequate protection of workers, the public, and the environment from adverse consequences, taking into account the work to be performed and the associated hazards. Nuclear safety analyses would be conducted and implemented for the selected test reactor to establish a safe operating envelope. Safety analyses will also be conducted for the test assemblies and test procedures will be developed that clearly identify the limits and requirements of test conditions and components. (Applies to Alternatives 1 and 2).

6 COORDINATION AND CONSULTATION DURING EA PREPARATION

6.1 Alternative 1

The INL Cultural Resource Management Plan (DOE-ID 2013b) guides the identification and management of cultural resources on lands under DOE-ID jurisdiction. The plan is legitimized through programmatic agreement between DOE-ID, the Idaho State Historic Preservation Office, and the Advisory Council on Historic Preservation. All parties to the agreement have reviewed the plan and agree upon the strategies and procedures outlined therein. Cultural resource investigations completed at INL for the program included archival and records searches to identify and evaluate historic structures and previously recorded archaeological resources, *intensive* and *reconnaissance level archaeological surveys* (see Glossary), field examination and evaluation of previously recorded cultural resources, and communication with representatives from the Shoshone-Bannock Tribes Heritage Tribal Office. On April 17, 2013, the Heritage Tribal Office representatives toured TREAT and the surrounding area and the defined areas of direct and indirect effect for cultural resources. The cultural resource investigations are summarized in a technical report (Pace and Williams 2013) that would be transmitted to the Idaho State Historic Preservation Office and Shoshone-Bannock Tribes to formally initiate consultation in coordination with the preparation of this EA.

6.2 Alternative 2

No coordination or consultation on cultural or biological resource matters was completed during EA preparation on the use of ACRR for the resumption of transient testing with other federal or state agencies. The analysis results indicate negligible potential impacts and no sensitive issues of concern that would have required contacts or for which contacts would be beneficial or informative. The New Mexico Environmental Department (NMED) and the Isleta Pueblo were notified and offered briefings on the proposed action and the preparation of the EA. A briefing was conducted for the NMED Director. Coordination was completed with the DOE Sandia Field Office NEPA Compliance Officer and other environmental program officials to ensure an effective exchange of information during the EA preparation process.

7 REFERENCES

- 7 USC § 2814, "Management of Undesirable Plants on Federal Lands," United States Code.
- 16 USC § 661 *et seq.*, "Fish and Wildlife Coordination Act," United States Code.
- 16 USC § 668, *et. seq.*, "Bald Eagle Protection Act," United States Code.
- 16 USC § 715, *et. seq.*, "Migratory Bird Treaty Act," United States Code.
- 16 USC, § 1531, *et seq.* , "Endangered Species Act," United States Code.
- Adams, B.A., R. Black, R. Grant, and L. Nelson, 2013, Projected Radioactive Waste Streams Generated from the Resumption of TREAT Operations, Idaho National Laboratory Environmental Management System Technical Interpretation, TI-058, June 2013.
- Hafla, J., J. C. Whiting, M. Case, and R.D. Blew, 2013, "Ecological Resources Assessment for the Resumption of Transient Testing of Nuclear Fuels and Material Environmental Assessment," Gonzales-Stoller Surveillance, LLC, Prepared for U.S. Department of Energy-Idaho Operations Office; Environmental Surveillance, Education, and Research Program, Contract No. DE-NE-0000300, June 2013.
- International Commission on Radiological Protection (ICRP), 1977, "Recommendations of the International Commission on Radiological Protection," ICRP Publication 26, Annals of the ICRP, Vol. 1, No. 3, Pergamon Press, Elmsford, NY.
- International Commission on Radiological Protection (ICRP), 1979–1988, "Limits for Intakes of Radionuclides by Workers." ICRP Publication 30, Parts 1–4 (and supplements), Annals of the ICRP, Vol. 2 (No. 3/4), Vol. 4 (No. 3/4), Vol. 6 (No. 2/3), Vol. 8 (No. 4), and Vol. 19 (No. 4), Pergamon.
- Kelly, J. G. and K.T. Stalker, 1981, "The CAIS Fuel Motion Monitoring Detection System – Development, System Design and Proof Tests," NUREG/CR-2140 and SAND81-1112, Albuquerque, NM.
- Kirtland Air Force Base (KAFB), 2006, "Final Predator Survey Report for Kirtland Air Force Base," Kirtland Air Force Base, Albuquerque, NM, April 2006.
- Kirtland Air Force Base (KAFB), 2007, "Baseline Natural Resources Inventory," Final Report. Kirtland Air Force Base, Albuquerque, NM, December 2007.
- Kirtland Air Force Base (KAFB), 2009, "Bat Diversity and Maternity Roost Study," Interim Report. Kirtland Air Force Base, Albuquerque, NM, June 2009.
- Nuclear Regulatory Commission (NRC), 2012, "Spent Fuel Transportation Risk Assessment," NUREG-2125, Rockville, MD.
- Pace, B. R. and J.B. Williams, 2013, "Cultural Resource Investigations for the Resumption of Transient Testing of Nuclear Fuels and Material," *INL/EXT-13-29097*, May 2013, Idaho Falls, ID. May 2013.
- Rowland, M.M., M.J. Wisdom, L.H. Suring, and C.W. Meinke, 2006, "Greater sage-grouse as an umbrella species for sagebrush-associated vertebrates," *Biological Conservation* 129:323-335.
- Sandia National Laboratories/New Mexico (SNL/NM), 1998, "SNL/NM Site-Wide Hydrogeologic Characterization Project, Calendar Year 1995 Annual Report," revised February 1998, Environmental Restoration Program, Sandia National Laboratories, Albuquerque, NM.
- Sandia National Laboratories/New Mexico (SNL/NM), 2012, "Calendar Year 2011 Annual Site Environmental Report for Sandia National Laboratories, New Mexico," SAND2012-7340P, Sandia National Laboratories, Albuquerque, NM, September 2012.

- Schafer, A. L., L. C. Brown, D. C. Carathers, B. D. Christensen, J. J. Dahl, M. L. Miller, C. Ottinger Farnum, S. Peterson, A. Jeffrey Sondrup, P. V. Subaiya, D. M. Wachs, R. F. Weiner, 2013, "Impacts Analyses Supporting the National Environmental Policy Act Environmental Assessment for the Resumption of Transient Testing Program." INL/EXT-13-29397, Idaho National Laboratory, Idaho Falls, ID, November 2013.
- Shumar, M.L. and J.E. Anderson, 1986, "Gradient Analysis of Vegetation Dominated by Two Subspecies of Big Sagebrush, *Journal of Range Management*," Vol. 39, No.2, pp. 156-160.
- Shurtliff, Q.R. and J.C. Whiting, 2009, "2009 Breeding Bird Surveys on the Idaho National Laboratory Site," Stoller-ESER Report No. 128.
- Ullrich, R. A., M.A. Sullivan, C. Martin, and D. Gerdes, 2010a, "Sandia in the Cold War and Post-Cold War Periods: A Statement of Historic Context for Sandia National Laboratories/New Mexico," SAND2010-4971 P, August 2, 2010.
- Ullrich, R.A., C. Martin, and D. Gerdes, 2010b, "Historic Building Survey and Assessment Sandia National Laboratories New Mexico Site, Albuquerque, New Mexico," Volume II: Appendices SAND2010-5646P, August 2, 2010.
- U.S. Department of Energy (DOE), 1994, "DOE Radiological Control Manual," DOE/EH 0256T, Revision 1, U.S. Department of Energy, April 1994.
- U.S. Department of Energy (DOE), 1999, "Final Site-Wide Environmental Impact Statement for Sandia National Laboratories/New Mexico," DOE/EIS-0281, U.S. Department of Energy-Albuquerque Operations Office, Albuquerque, NM, October 1999.
- U.S. Department of Energy (DOE), 2006, "Final Supplement Analysis for the Final Site-Wide Environmental Impact Statement for Sandia National Laboratories/New Mexico, Albuquerque, New Mexico," DOE/EIS-0281-SA-04, U.S. Department of Energy, National Nuclear Security Administration, Sandia Site Office, Albuquerque, NM, August 2006.
- U.S. Department of Energy (DOE), 2010, "Mission Need Statement for the Resumption of Transient Fuel Testing (MNS)," December 3, 2010.
- U.S. Department of Energy (DOE), 2013, "Idaho National Laboratory, Alternatives Analysis for Resumption of Transient Testing Program," INL/EXT-13-28597, Revision 2, Idaho National Laboratory, October 2013.
- U.S. Department of Energy – Idaho Operations Office (DOE-ID), 2013a, "National Emission Standards for Hazardous Air Pollutants—Calendar Year 2012 INL Report for Radionuclides," DOE/ID-11441, June 2013.
- U.S. Department of Energy – Idaho Operations Office (DOE-ID), 2013b, "Idaho National Laboratory Cultural Resource Management Plan," DOE/ID-10997, Revision 5, Idaho Falls, ID February 2013.
- Whiting, J.C. and B. Bybee, 2011, "Ecology and management of bats on the INL Site." U.S. Department of Energy-Idaho Operations Office; Environmental Surveillance, Education, and Research Program.